SCIENCE ABSTRACTS.

Section A.—PHYSICS.

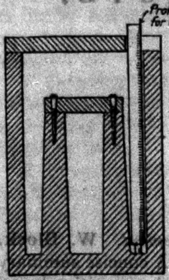
DECEMBER 1924.

GENERAL PHYSICS.

2877. *The Limits of Accuracy in Physical Measurement.* **W. Block.** (Zeits. Instrumentenk. 44. pp. 366–370, Aug., 1924.)—A concise summary of the limits of accuracy of measurement of physical quantities based on the fundamental units of time, length and mass. The measurement of length is referred to the standard international meter in terms of wave-length of light. Brief mention is made of the various methods of standardisation of physical units, and the limits of accuracy of each is stated. It is shown that almost theoretical accuracy can be obtained in the case of length and mass units. The paper furnishes a useful collection of details concerning limits of accuracy in physical measurement of standard units. S. G. B.

2878. *The Density of Iron and Other Refractory Metals in the Liquid State.* **C. Benedicks.** (Comptes Rendus, 179. pp. 389–391, Aug. 18, 1924.)—Two **U**-tubes, one containing mercury and the other made of some refractory material, are connected so that two of their limbs are filled with an inactive gas at a low pressure, and the other two with the same gas at a higher pressure; and the differences of height of the mercury in the limbs of one **U**-tube, and of the molten metal in those of the other, are determined. In some cases refractory glass, or fused silica, can be used for the second **U**-tube, and the difference in level can be determined optically; in others the position of the meniscus can be found by means of tungsten rods, the expansion of which has been determined. For tin, using the first method, the density has been determined as $s = 6{\cdot}95$; at 320° ± 5° C. Arpi found 6·90; Day, Sosman and Hostetter 6·92. For lead $s = 10{\cdot}47$ at 500° ± 5° C.; Arpi 10·53; Day 10·477. For iron a **U**-tube was built up, using magnesia and bauxite with inner tubes of carbon; this was heated by means of an alternating current. The tungsten rods were protected from solution in the iron by means of a thin layer formed of MgO, CSi and molasses; at 1540° $s = 6{\cdot}92 \pm 0{\cdot}07$. The value of Roberts-Austen and Wrightson, 6·88, is for cast iron containing 5 to 8 per cent. of foreign matter, and the temperature was probably not above 1200°. The iron was allowed to solidify in the tube with a definite difference of pressure, 27·80 mm. Hg; the tube was destroyed, and the vertical distance between the two iron surfaces was measured (about 55 mm.). Allowing for contraction, at the temperature of solidification, about 1525°, $s = 6{\cdot}83$. A certain amount of cementation took place from the carbon tubes; the probable amount of carbon was from 0·20 to 0·25 per cent. H. N. A.

2879. *Weights and Measures.* (Bureau of Standards, Dept. of Commerce, Misc. Publ. No. 55. [153 pp.] 1924.)—Sixteenth annual conference of representatives from various states held at the Bureau of Standards, Washington, D.C., May, 1923.



2880. *Density of Magnesium from* 20° *C. to* 700° *C.* **J. D. Edwards** and **C. S. Taylor.** (Am. Inst. Mining Eng., Trans. 69. pp. 1070–1074; Disc., 1075, 1923.)—The density was measured at room-temperature by comparison of the weight in air and when immersed in distilled water, with the results (at 20° C.) given in Table 1. When measuring the density of liquid magnesium use was made of a small graphite or steel crucible, as shown in the figure, the annular space being filled with molten tin to give a uniform temperature distribution. The apparatus was heated in an electric furnace and the temperature measured by a platinum, platinum-rhodium thermocouple. The results are given in Table 2.

TABLE 1.—*Density of Magnesium at* 20° C.

Purity of Test Pieces, per cent. Magnesium.	Density at 20° C., Grammes per Millilitre.	Remarks.
99·99	1·7388	As extruded
99·99	1·7388	Same, annealed 2·5 hrs. at 400° C.
99·95	1·7381	As extruded
99·94	1·7386	As extruded
99·90	1·7381	As extruded

TABLE 2.—*Density of Magnesium from* 20° C. *to* 700° C.
(Purity of magnesium, 99·99 per cent.)

Temperature, Degrees C.	Density, Grammes per Millilitre.	Kind of Densimeter Used.
20	1·7388	—
667	1·560	Graphite
667	1·565	Graphite
673	1·562	Steel
711	[1·538?]	Graphite
768	[1·445?]	Graphite
822	[1·478?]	Graphite

T. C. H.

2881. *A Standard Barometer of New Design.* **T. H. Laby.** (Journ. Sci. Instruments, 1. pp. 342–345, Aug., 1924.)—A standard barometer is described in which the distance between the mercury surfaces is measured by means of the equivalent of a 30-inch steel screw micrometer. To do this the upper end of the micrometer is sealed into the vacuum chamber of the barometer. The lower end is the divided head of the micrometer. A vacuum tube is attached to test the pressure in the vacuum chamber. The micrometer can be easily set on the mercury surfaces to 1/1000 of an inch, and standardized by a rod end-gauge to a few ten-thousandths of an inch. This design of standard barometer eliminates the cathetometer usually used with such instruments and the difficulties and errors of reading mercury surfaces enclosed in glass tubes.
AUTHOR.

2882. *A Manometer of High Sensitivity.* **L. Heis.** (Phys. Zeits. 25. pp. 326–330, July 1, 1924.)—The instrument is a diminutive form of Edelmann manometer provided with two pressure ducts which act upon two thin aluminium vanes, respectively, at each end of a small indicator. The vanes are mounted at the two ends of a thin aluminium wire suspended horizontally at its centre so that the vanes and carrier rotate in the horizontal plane. The suspension is specially designed for sensitivity, and the deflections are recorded by the movement of a spot of light on a horizontal ground-glass scale, which is reflected from a small mirror attached to the vertical suspension wire. The scale is usually placed 2 metres from the instrument. The vanes are suitably protected in an aluminium tube and the pressure blasts are directed at them through holes in a plate forming the end of the ducts. Particular care is taken to screen the instrument from external magnetic or thermal influences, and the elimination of electrostatic effects is eliminated by an all-metal construction of the apparatus. Full details, diagrams and dimensions are given. The variety of work for which the instrument is suitable is enumerated, and a new method is developed both theoretically and practically for finding the susceptibility of gases. A general formula for such work is deduced and experimental results quoted. The sensitivity of the instrument is such that a deflection of 1 mm. on a scale placed 2 metres from the indicating mirror corresponds to a static pressure difference of $2\cdot7 \times 10^{-8}$ mm. of mercury. Various other detailed cases are quoted.
S. G. B.

2883. *A Constant Precision Manometer.* **A. F. Zahm.** (Frank. Inst., J. 198. pp. 213–216, Aug., 1924.)—A liquid differential pressure gauge in which the manometer tube is shaped to the equation of a tractrix, so that the displacement of the liquid meniscus along the bore at any point is in a constant ratio to the proportional change of pressure, is described. The application and calibration of the gauge for measuring wind velocities are briefly referred to.
J. S. G. T.

2884. *Modern Pressure Meters, with Special Reference to the Recording Manometer.* **J. Wohlfarth.** (Zeits. techn. Physik, 5. 9. pp. 361–368, 1924.)—Describes the methods employed in the manufacture of the curved spring tubes (Bourdon tubes) made use of in commercial manometers and the method of calibration employed. An example is given which shows the advantage to be gained by employing a self-recording manometer in connection with a boiler. Figures are given of self-recording instruments, in which the pen is caused to move in a straight line instead of the usual circular arc by means of suitable mechanism. H. N. A.

2885. *The Piston Motion of the Pressure Gauge.* **L. Holborn.** (Ann. d. Physik, 75. 3. pp. 276–278, Sept., 1924. From the Reichsanstalt).—In two recent papers [see Abstracts 5 and 1361 (1924)] A. Michels has examined the accuracy and sensitivity of a pressure gauge due to Schäffer and Budenberg. The present paper is a criticism of the findings of Michels with reference to previous work of the author [see Abstract 1007 (1923)]. A. E. G.

2886. *Coupled Cord Pendulums.* **C. H. Lees.** (Phil. Mag. 48. pp. 129–141, July, 1924.)—The interest which has been aroused by oscillograph investigations of the electrical oscillations in the coupled circuits used in wireless telegraphy has led to a revival of the study of coupled dynamical systems in general, and new systems have been invented and their properties studied, either theoretically or experimentally, in order to facilitate the subsequent study of the properties of coupled electrical circuits. [See Barton and Browning (1917–1924); Plummer, Abstract 138 (1918); Jackson, Abstract 1932 (1921); Narayan, Abstracts 1232 and 1233 (1922).]

These studies, though adding much to our knowledge of the consequences of dynamical coupling, have not always had the theoretical work given in a form which admits of the principal features of the oscillations being readily recognised.

The present paper presents the theory of one of the simplest forms of coupled pendulums, and shows that, by neglecting the small damping that occurs, by using a symmetrical notation and dealing at first with inclinations rather than displacements, the work may be reduced to the *determination of a certain length,* whose addition to or subtraction from other lengths gives the altered effective pendulum lengths for the coupled vibrations, and thus enters into the expression of the periods and amplitudes of the component oscillations in question.

By means of this length a graphical solution is given, so far as it is independent of the initial conditions of the oscillations.

To illustrate the working of the graphical method four cases are taken, *viz.* masses and lengths each equal, masses equal but lengths unequal, lengths equal but mass unequal, both masses and lengths unequal. The original paper should be consulted for details for the analysis and the graphical method (which involves only two circles and three straight lines). E. H. B.

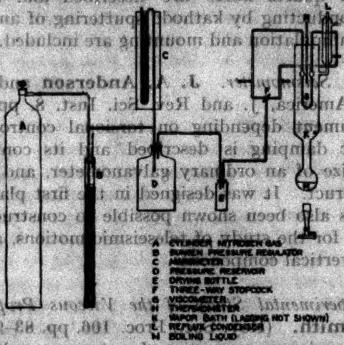
2887. *Automatic Töpler Pump.* **F. Porter.** (Indust. and Engin. Chem. 16. pp. 731–732, July, 1924.)—This paper contains a brief description of the essential features of a mercury pump, working automatically and continuously, which has been developed in connection with the work in the Cryogenic Research Laboratory, Bureau of Mines, Washington, D.C. In this work, particularly in analyses for helium, a vacuum pump is required which will evacuate the apparatus and deliver the gas into a collection tube. The Töpler pump is more satisfactory than the Sprengel, but earlier developments of pumps of Töpler type to work automatically and continuously have resulted in very complicated glass apparatus requiring a skilled glass-blower to set up and maintain [see Abstract 1407 (1910)]. In the present apparatus the glass parts have been kept comparatively simple, electrical controls being used. M. A. G.

2888. *The Preparation and Silvering of Quartz Fibres.* **T. C. Keeley.** (Journ. Sci. Instruments, 1. pp. 369–373, Sept., 1924.)—Several methods of preparation of quartz fibres are described and details given for rendering them conducting by kathode sputtering of any suitable metal. A few hints on manipulation and mounting are included. AUTHOR.

2889. *Torsion Seismometer.* **J. A. Anderson** and **H. O. Wood.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 817–822, June, 1924.)—An instrument depending on torsional control and possessing variable magnetic damping is described and its contents considered. It is about the size of an ordinary galvanometer, and is very portable and easy to construct. It was designed in the first place to study local shocks, but it has also been shown possible to construct an instrument on the same lines for the study of teleseismic motions, and can be made for horizontal or vertical components. W. A. R.

2890. *An Experimental Study of the Viscous Properties of Water-Vapour.* **C. J. Smith.** (Roy. Soc., Proc. 106. pp. 83–96, July 1, 1924.) —The study of the viscous properties of water-vapour has received little attention in the past, and there is no record of any systematic attempt to obtain results over a large range of temperature. The principal difficulty when the range of temperature is such that the vapour will behave approximately as a perfect gas has been reduced by using the vapour at comparatively low pressures, so that considerable superheating may be obtained without the attainment of very high temperatures. Within the range used, 100°–260° C., the viscosity appears to be independent of pressure—a result only to be expected, according to the kinetic theory, in so far as the superheated vapour obeys the laws of a perfect gas. The method used involves the transpiration of the vapour through a capillary tube, and the objection to the method—*viz.* its dependence on the assumption that Boyle's law is applicable to the gas or vapour under investigation—appears to be met by the above result, making it possible to adopt this method in preference to those depending on damping of oscillations, on account of the greater facility with which the variation of viscosity with temperature can be observed. Attempts were first made to use an apparatus constructed of fused quartz, thereby to cover a still larger range of temperature; these, however, were unsuccessful, due to non-uniformity of capillaries and fragility of quartz tubes marked with scratched variations. The soda-glass which had to be used eventually caused the upper temperature limit to be fixed owing to the chemical action of water-vapour. The experimental details are given very fully, with diagrams, and the data obtained have been applied to estimate the size of the water molecule in the gaseous state. Using Chapman's formula, the mean area presented for collision by the water molecule in thermal agitation is $A = 0\cdot49 \times 10^{-15}$ cm.^{2}. A discussion is included in relation to the recent work on the corresponding magnitudes for other gaseous hydrides. The range of temperature covered by the observations is too small to provide adequate verification of Sutherland's law. H. H. Ho.

2891. *Viscosity of Oils at High Temperatures.* **A. R. Fortsch** and **R. E. Wilson.** (Indust. and Engin. Chem. 16. pp. 789–792, Aug., 1924.)—Temperatures up to 250° F. were obtained by immersing a modified type of Ostwald viscometer in an oil bath provided with close thermostatic regulation and with glass windows, so that the observations could be taken through the bath liquid. Beyond 250° F. a special vapour bath was devised, as shown in the figure, the liquids used for the vapour bath being as under :—



Liquid.	Boiling-point ° F. (approx.).
Xylene	280–287
Aniline	363–364
Naphthalene	424
Diphenol ether	495

The data on the various oils are given in a comprehensive table, and are also plotted according to Herschel's method, where log viscosity is plotted against log temperature (° F.). T. C. H.

2892. *Viscosities of Some Monovalent Salts of Higher Fatty Acids in Organic Solvents.* **M. Prasad.** (J. Phys. Chem. 28. pp. 636–643, June, 1924.)—The values of the viscosities of solutions of various concentrations of five different soaps in ethyl, n-butyl, and isobutyl alcohols are compared with the values calculated from Einstein's and Hatschek's formulæ. In agreement with the theoretical assumptions on which the first of these formulæ is based, the observed values are more in accord with this formula for low concentrations of the solute. In all cases the value of the constant θ of the equation $\log\frac{\eta_v}{\eta_0} = \theta c$, where c is the volume-fraction of the solute per unit volume of the solvent, are greater than the values found by Arrhenius, and, further, the value of the constant varies with the nature of the solute and solvent.

Ethyl alcohol consists of highly associated molecules which undergo dissociation on dilution and Horiba (Tokyo Chem. Soc., 31. 922, 1910) show that, for aqueous ethyl alcohol solutions, the quotient $\frac{\log \eta}{c}$ decreases as the concentration c increases. A similar observation was made by Baker (Chem. Soc., J. 103, 1653, 1913) for solutions of nitrocellulose in acetone. The results of the present investigation show, however, that in almost all cases the Arrhenius constant, $\frac{1}{c} \cdot \log \frac{\eta_v}{\eta_0}$, increases with increasing concentration. No alteration in the time of flow was noted when the solutions were left for a week before measurement.

If the values of the conductivity of the different soaps in ethyl and n-butyl alcohols are corrected for the viscosity, the curves connecting V and $\frac{\mu_v \cdot \eta_v}{\eta_0}$ are in all cases rectilinear. T. H. P.

2893. *The Viscosities and Surface Tensions of the Soda-Lime-Silica Glasses at High Temperatures.* Part I.—*The Viscosity of Glass at High Temperatures.* **E. W. Washburn** and **G. R. Shelton.** Part II.—*Surface Tensions of Glasses at High Temperatures.* **E. W. Washburn** and **E. E. Libman.** (Univ. of Illinois, Eng. Exp. Sta., Bull. No. 140. [71 pp.], April 14, 1924.)—*Part I.*—The authors give a brief survey of previous investigations on this subject. The method adopted by them was a modification of the rotating cylinder method originally used by Margules, in which the liquid under investigation is confined between two coaxial cylinders, one of which is rotated at a measured speed, and the force required to produce the rotation is measured. The apparatus was standardised by means of a series of glucose glasses, the higher viscosities being obtained by the addition of pure dextrose. The viscosities of the standardising glasses were obtained by three methods—the capillary-flow method, the falling-sphere method and the capillary-penetration method. From the calibration curve of the apparatus thus obtained the viscosity of any glass measured in the apparatus can be determined independently of any knowledge of the theory of the apparatus, the method being substantially one of substitution. The viscosities of sixteen soda-lime-silica glasses covering the composition area of commercial glasses of this type were measured over the temperature range of 800° to 1500° C. The viscosities ranged from 0·05 to 200,000 poises. The results are presented in the form of a series of isothermal projection diagrams, with the aid of which it is possible to ascertain the viscosity of any glass at any temperature within the range of compositions and temperatures studied. Early in the investigation a second brass apparatus was constructed to test the applicability of the theoretical equation for the rotating cylinder method when applied to liquids of high viscosity. The standardised glasses were used, and it was found that the equation is valid in the case of the brass apparatus for viscosities up to about three poises, but for higher viscosities the constant of the apparatus is a function of the viscosity. It was also found that, regardless of the viscosity of the liquid employed, the rate of shearing is directly proportional to the torque, as is required by the theoretical equation, and that none of the glasses exhibited plastic flow.

Part II.—In a preliminary investigation the authors tried a variety of methods at room temperatures, and finally decided to adopt a modification of the Dipping cylinder method to suit glass at high temperatures. The final apparatus consisted of a platinum resistance pot furnace, in which a platinum cylinder (about 12 cms. in apparent external circumference) was suspended on a platinum wire from a Jolly spring balance, the wire passing through the electrically heated cover of the furnace. By measuring the extension of this spring with a cathetometer, the surface tension of the glass can be calculated. For standardising, four viscous liquids ranging in viscosity from 10 to 4000 poises were prepared by dissolving rosin in benzyl benzoate. The surface tensions of these liquids were determined by the capillary-rise method, using glass capillaries and approaching the equilibrium from both directions.

With this apparatus the surface tensions of fourteen glasses were measured at 1206° C. and 1454° C. The values obtained varied from 128 to 167 dynes per cm. Surface Tension-Space models were constructed, from which the surface tension of any glass within the range of compositions investigated may be obtained for each of these temperatures. The compositions investigated included all the commercial soda-lime-silica glasses. The temperature coefficient of the surface tension at the temperatures measured was found to be very small, varying between 0·02 and 0·04 per cent. per degree C. W. C. S. P.

2894. *Does the zn/p (Lubrication) Function fit the Facts?* **A. E. Becker.** (Indust. and Engin. Chem. 16. pp. 856–857, Aug., 1924.)—According to Barnard, Myers and Forrest (Indust. and Engin. Chem. 16. p. 347, 1924), identical values of the coefficient of friction, f, are obtained for the same value of $\frac{zn}{p}$, regardless of changes in the individual variables, z being the viscosity of the oil at the temperature of the oil-film in a bearing, n the number of revolutions of the shaft per minute, and p the nominal pressure on the bearing in pounds per sq. inch. The author fails to find any basis for this statement, and in support of his argument quotes the results obtained by Tower with journals lubricated with lard, sperm, and rope oils (Inst. Mech. Engin., Proc. No. 4. p. 632, 1883).

Further, the data of Barnard, Myers and Forrest would indicate that a glycerol-water solution should give as good lubrication in the fluid film region as an animal, vegetable, or petroleum lubricant of the same viscosity, which is hardly in agreement with practical experience. T. H. P.

2895. *The Variation of Young's Modulus at High Temperatures.* **C. H. Lees, J. P. Andrews** and **L. S. Shave.** (Phys. Soc., Proc. 36. pp. 405–416, Aug., 1924.)—The depression at the free loaded end of a cantilever 4 cm. long in an electric furnace is measured by a microscope. The temperature of the furnace is measured by a platinum resistance thermometer. For aluminium, nickel and platinum Young's modulus is found to diminish slightly with increase of temperature up to an absolute temperature about half the absolute temperature of the melting-point of the material, then to decrease more rapidly and to tend to zero as the melting-point is approached. When the modulus begins to decrease more rapidly viscous flow of the material is first noticed. For fused quartz the modulus increases slowly with rise of temperature up to about 700° C. and then decreases. AUTHORS.

2896. *The Principle of Virtual Velocities and its Application to the Theory of Elastic Structures.* **E. H. Lamb.** (Inst. Civ. Eng. Selected Eng. Papers, No. 10. [56 pp.], 1923.)—In the designing of engineering structures a number of problems arise which cannot be solved by the ordinary principles of statics alone, but for their solution require account to be taken of the elastic properties of the members. The object of this paper is to show how the principle of virtual velocities provides a simple means of developing Maxwell's equations for framed structures, and that the method can be applied to the solution of a much more extensive class of problems than Maxwell contemplated, as well as to a simple proof of Castigliano's theorem of least strain-energy. One great advantage of the proposed method of treatment is that, while incidentally yielding the same equations as can be derived by the principle of least strain-energy, the theory can be established by very straightforward reasoning from first principles and without the necessity of considering the strain-energy. From the practical standpoint there is the advantage that less labour is entailed than in employing Castigliano's method, and the various stages in the progress of the work are less artificial, and can be conveniently tabulated and checked. § I gives an elementary account of the principle of virtual velocities and the theorems employed in the paper. § II deals with an extension to systems of particles. § III treats of examples relating to stresses in statically-determinate frames. § IV considers deformations of framed structures by Maxwell's method. § V investigates frames with one redundant member, and § VI with several redundant members. In § VII the strain-energy and Castigliano's principle are examined. § VIII contains an extension of Maxwell's method to problems involving flexure, torsion, etc. In § IX miscellaneous problems are treated by virtual work. The latter method suggests an interesting treatment of problems on continuous beams and metal arches, and this is contained in § X. Finally § XI includes some theorems relating to the strain-energy. The paper, which is entirely mathematical, is accompanied by twenty-two diagrams. H. H. Ho.

2897. *The Inapplicability of the Equipartition of Energy in a System comprising Vibrating or Rotating Particles.* **G. Jaffé.** (Ann. d. Physik, 74. 7. pp. 628–660, July, 1924.)—A system of free and elastically bound atoms is considered, the time of vibration being small compared with that of impact, and it is shown that the energy of the vibrators tends to zero as the period tends to zero. Similarly for rotating and free particles, the period of rotation being small compared with the time of impact. W. G. B.

2898. *On the Collision of Spherical Bodies of Unequal Diameter and Densities at Very Low Velocities.* **D. B. Deodhar.** (Phil. Mag. 48. pp. 89–96, July, 1924.)—In all cases the coefficient of restitution is found to approach a limit 1 as the velocity of approach tends to zero. It is suggested that the energy "lost" in impact is really used in effecting slight surface molecular changes; this accounts for the decrease of the "loss" at low velocities. W. G. B.

2899. *Experiments on the Duration of Impacts.* **J. E. P. Wagstaff.** (Phil. Mag. 48. pp. 147–158, July, 1924.)—In a previous paper [Abstract 2001 (1924)] a formula was obtained for the duration of impact of rods with rounded ends, $t = (Mr^2/a + B_1 l)v^n V^{-n-1}$. The form of the mathematical relationships which might produce such a formula is investigated. It is suggested that, for the intense stresses at impact, the stress-strain relation is of the form stress $=$ (strain)$^\beta$, and a formula of the above type is deduced in which $n = (1 + \beta)/(1 - \beta)$.

The effect of magnetisation is studied, one bar being made of non-magnetic steel. The duration of impact is found to be unaltered, but on removing the magnetic field and taking a series of observations, one here and there is found to be distinctly less than the average. It is taken as indicating molecular rearrangement, the molecular structure induced by magnetisation breaking down intermittently under the shock of impact. The effect of temperature is found to be practically negligible. W. G. B.

2900. *The Equation of Long Waves in Canals of Varying Section.* **N. Sen.** (Phil. Mag. 48. pp. 65–78, July, 1924.)—An investigation of the various types of solution and methods of solving, from a standpoint mainly mathematical. W. G. B.

2901. *Wave Power Transmission.* **E. A. Barclay-Smith.** (Phil. Mag. 48. pp. 97–109, July, 1924.)—The theory of the Constantinesco wave power transmission is obtained by elementary methods, and exhibited by vector diagrams analogous to those in use in the treatment of alternating electric currents. W. G. B.

2902. *Stability and Turbulence of Fluid Streams.* **W. Heisenberg.** (Ann. d. Physik, 74. 7. pp. 577–627, July, 1924.)—Mathematical. It is shown that in discussing the stability of laminar motion the viscous terms must be taken into account in the disturbed motion, and that Rayleigh's method of approximating to the velocity curve by a polygon cannot lead to the information sought. A discussion leads to very complicated formulæ, and numerical computation indicates a limiting Reynolds number near 10^3. The mathematical discussion of turbulent motion is not easily abstracted. W. G. B.

2903. *The Ballistic Principle in the Propagation of Light and Several New Investigations of Rudolph Tomaschek.* **M. la Rosa.** (Ann. d. Physik, 75. 2. pp. 195–200, Aug., 1924. Accad. Lincei, Atti, 33. 1. pp. 471–474, June 15, 1924.)—The author replies to the criticism of Tomaschek [Abstract 2207 (1924)] of the views put forward in a previous paper published by him on the ballistic principle of light propagation [Abstract 1410 (1924)]. It is reaffirmed that the ballistic theory must be regarded as based on the facts of experiment and practical knowledge which embraces the whole of the real truth of the case. Tomaschek's paper is criticised in detail. S. G. B.

2904. *The Crystal Structures of the Rhombohedral Forms of Selenium and Tellurium.* **A. J. Bradley.** (Phil. Mag. 48. pp. 477–496, Sept., 1924.)—The powder photograph method was used, the arrangements being the same as for arsenic [Abstract 1686 (1924)]. The measurements are shown to indicate that the structure of the crystals constitutes a Sohncke trigonal point system No. 23 or No. 24; these are right and left alternating 3-point screw systems, one being the mirror image of the other. The observed order of intensity of reflection is consistent with a value of the parameter $2\pi x = 78°$. The same two systems are the only possible arrangements for tellurium; here a value of $2\pi x$ of about 96° or 97° appears quite satisfactory. The "total error" is greater than in the case of selenium, owing to the inferiority of the films. The structure is explained with the help of diagrams. The atoms are arranged in threefold spirals around the trigonal axes; every third atom occupies the same position if projected on a plane perpendicular to these axes. In selenium each spiral is isolated from its neighbours; each atom is 2·32 Å. distant from two atoms in the same spiral, and 3·49 Å. from four in adjacent spirals. It is possible that for this reason crystals will tend to grow more readily in the direction of the trigonal axes, thus accounting for the needle crystals observed by Brown; the production of lamellar crystals may be due to the same cause. If $2\pi x = 120°$ the structure would be a simple rhombohedral lattice. The three interpenetrating triangular lattices fit together to form a structure which is almost simple cubic, each atom being slightly displaced towards two of the six adjacent atoms, and in this respect Se and Te resemble the elements of Group V. The paper includes photographs of models of the atomic structures of the two elements. The crystal structures of elements of Groups IV, V and VI differ from group to group in virtue of the difference in negative valency, which regulates the direction of displacement from the simple cubic structure. In the same group the heaviest atoms are least shifted. H. N. A.

2905. *An Experimental Investigation of the Lattice Structure of Certain Alloys.* **S. Holgersson** and **E. Sedström.** (Ann. d. Physik, 75. 2. pp. 143–162, Aug., 1924.)—The alloy series PdAu and PdCu have been examined by the Debye-Scherrer method. The first series has a face-centred cubical lattice; the variation of the lattice parameter with the atomic concentration is represented graphically by a curve which is convex towards the concentration axis. In the case of the PdCu alloys the existence of a compound PdCu is proved with 50 per cent. (atomic) of Pd. This has the same structure as CsCl, $a = 2 \cdot 988 \times 10^8$ cm. For other concentrations the structure is face-centred cubic, except in the immediate neighbourhood of the above chemical compound, where there is a mixture of crystals with both lattices. H. N. A.

2906. *The Lattice Structure of Rhombic Sulphur.* **H. Mark** and **E. Wigner.** (Zeits. phys. Chem. 111. pp. 398–414, Aug. 25, 1924.)—Two finely developed natural crystals, one grown in CS_2, and a large number of small crystals of from 1 to 2 mm. were investigated in detail, using monochromatic X-rays from a copper antikathode ($\lambda = 1 \cdot 54$) instead of those from molybdenum employed by Bragg ($\lambda = 0 \cdot 712$). Owing to the large dimensions of the lattice element this produced a great improvement in the photographs of the interferences. The knife-edge method was employed, using the different natural planes of the crystals, and rotating crystal diagrams were also taken about different axes. The crystals are rhombic bipyramidal, $a = 10 \cdot 61$ Å., $b = 12 \cdot 87$ Å., $c = 24 \cdot 56$ Å.; space group V_h^{24}; the elementary cell is face-centred on all sides, and contains 128 atoms. In this lattice groups of at most sixteen S atoms can be geometrically combined together. The centres of gravity of these groups form a rhombic diamond lattice. H. N. A.

2907. *The Analysis of Crystal Structure by X-Rays.* **W. H. Bragg.** (Engineering, 118. pp. 349–350, Sept. 5, and pp. 428–430, Sept. 19, 1924. Abstract of paper read before the British Assoc., Toronto, 1924. Science, 60. pp. 139–149, Aug. 15, 1924.)—Explains, with the help of diagrams for the C_{2v}^{1}, C_{2v}^{2}, C_{2v}^{3} . . . C_{2v}^{10} modes, how the 32 classes of crystals, with different external symmetry, can be divided into 230 modes by means of definite shifts of four lattices, Γ_0, Γ_0', Γ_0'', Γ_0'''; and how, in many cases, X-ray analysis gives information as to the mode. It is shown that, in the case of zincblende, it is possible, in spite of the polarity of the crystal, to determine the mode of arrangement of the atoms from X-ray measurements alone, though the X-rays cannot detect polarity directly. There are cases where the X-rays cannot decide between two modes, one of which can be derived from the other by the addition of a centre of symmetry, the existence of which, however, can generally be decided by other means. The unit cell of a crystal can be divided into 1, 2, 3, 4, 6, 8, 12, 24 or 48 "parts"; each is without symmetry, but capable of coincidence with any other part by a combination of reflections, rotations and shifts; the division into modes refers to the arrangement of these parts. In benzoic acid each part is a molecule, four to the unit cell, some right-handed and some left-handed. The molecule may have symmetry and consist of two, three or more "parts," as in FeS_2, which has six parts; and in rock-salt each atom of Na and Cl, in its relations to its neighbours, has 48 parts. Rarely a part consists of more than one molecule; the part in the fumaric acid crystal contains three, perhaps six, molecules. Since the part has no symmetry, the molecules differ in some way from one another. The general results link up with ordinary chemistry, and the chemical molecule generally seems to take its place, as such, in the crystal, with every little damage. The X-rays do not tell directly the relative positions of the atoms in the unit cell; much has been learnt as to the relation between these positions and the relative intensities of the different orders of reflection by each plane. It is difficult to state the distance between one atom and another, but the atomic radius is a useful conception, especially when its dependence on the nature of combination is taken into account. The question of the mutual orientation of the bonds is also dealt with, with special reference to carbon. A number of interesting compounds are described, and the connections between structure and dielectric capacity, rigidity, compressibility, thermal and electric conductivity and magnetic constants all offer scope for much future work. H. N. A.

2908. *Brownian Motion of the Same Test Body at Different Gas Pressures.* **S. Landman.** (Zeits. f. Physik, 27. 4. pp. 237–247, 1924.)—With lower pressures the Brownian motion, as expected, was in general livelier. If from the Brownian motion at atmospheric pressure the radius of the particle is calculated, it is found to agree with the Knudsen-Weber law of force. The mean value for Loschmidt's number is found as $N = 6{\cdot}03 \times 10^{23}$. [See Abstract 153 (1915).] E. H. B.

2909. *Remarks on the Author's Publication: The Basis of the Quantum Theory.* **H. A. Senftleben.** (Zeits. f. Physik, 28. 2. pp. 95–101, 1924.)—In the recently published Part I of this investigation [see Abstract 1688 (1924)] a certain amount of incompleteness was admitted and reserved for further examination. The latter is now based upon field equations for the charge-free vacuum in place of the usual equations of Lorentz, which strictly affords the field of uniformly moving charges only, while application to non-uniform motion is only possible to a certain degree of approximation. The model is then characterised by a number of parameters—impulse, energy, rotation impulse—and leads to a fundamental dynamic equation which stands in immediate relationship to the radiation. It follows that the system is spatially bounded by a finite closed surface, the conditions for which are evaluated. The paper is entirely mathematical. H. H. Ho.

2910. *The Atomic Structure of Two Intermetallic Compounds.* **E. A. Owen and G. D. Preston.** (Phys. Soc., Proc. 36. pp. 341–348, Aug., 1924.)—The two intermetallic compounds, Mg_2Si and AlSb, have been examined by the X-ray spectrometer with the following results: Mg_2Si.—A face-centred cubic lattice of silicon atoms of side 6·391 Å. symmetrically intermeshed with a simple cubic lattice of magnesium atoms of side 3·19 Å. There are eight magnesium atoms situated within each face-centred cube of silicon atoms, dividing the four cubic diagonals in the ratio 1 : 3 and 3 : 1. Density from X-ray data 1·95 ± 0·05 gms./c.c. The magnesium atoms are separated by the same distance as in the pure metal. The sum of the "radii" of silicon and magnesium atoms is equal to the distance between these atoms in the compound. AlSb.—A face-centred cubic lattice of antimony of side 6·126 Å. intermeshed with an identical lattice of aluminium atoms, the corner of the latter dividing the cubic diagonal of the former in the ratio of 1 : 3. Density from X-ray data 4·23 ± 0·04 gms./c.c. The molecular volume of the compound is greater than the sum of the atomic volumes of its constituents. The increase in volume observed by the method of X-ray analysis agrees with that obtained by other methods of measurement. The volume of the lattice on which the antimony atoms are arranged is 4 per cent. less than the volume of the face-centred rhomb found in pure antimony. The molecular volume of the compound is accordingly 4 per cent. less than twice the atomic volume of antimony. The closest distance of approach of aluminium and antimony atoms is 2·65 Å., which is less than the sum of their "radii" as determined from the pure metals. AUTHORS.

2911. *Structure of Calcium.* **H. Collins.** (Chem. News, 129. pp. 95–97, Aug. 15, 1924.)—The atom of calcium is considered to be formed either by the union of one of potassium and one of hydrogen, or, what is equivalent to this, by the union of an atom of silicon and one of carbon. Support for this conclusion is deduced from the specific gravities of a number of calcium compounds. T. H. P.

2912. *Structure of Cobalt.* **H. Collins.** (Chem. News, 129. pp. 107–108, Aug. 22, 1924.)—Experimental data are quoted in support of the view that the atom of cobalt is composed of one of aluminium united to one of sulphur. T. H. P.

2913. *Structure of Copper.* **H. Collins.** (Chem. News, 129. pp. 157–158, Sept. 12, 1924.)—Since Cu acts sometimes like the monad Na and at other times like the diad Ca, the constitution Na Ca, previously obtained for it, is particularly suitable. That such constitution is correct is shown by the facts that (1) four of the five combining volumes may be split up into parts in accordance with the law of relative volume; (2) three of the combining volumes are supported by the law of heat of formation and give the same original volume for the element. T. H. P.

2914. *Distribution of Atoms in Mixed Crystals.* **G. Tammann.** (Ann. d. Physik, 75. 2. pp. 212–216, Aug., 1924.)—According to Borelius [Abstract 2356 (1924)], no foundation exists for the interpretation of the limits of chemical action on the assumption of a definite distribution of the atoms. The author discusses the arguments for and against the normal atomic distribution with mixed crystals. T. H. P.

2915. *Crystal Structure of Oxalic Acid.* **H. Hoffmann** and **H. Mark.** (Zeits. phys. Chem. 111. pp. 321–356, Aug. 25, 1924.)—By means of the method previously described [Abstract 1753 (1923)] it is found that anhydrous oxalic acid crystallises in rhombic bipyramids of the space group V_h^{15}, the dimensions of the elementary cell being $a = 6\cdot46$ Å., $b = 7\cdot79$ Å., and $c = 6\cdot02$ Å. The cell contains four molecules $(CO_2H)_2$, and no connection between these molecules within the lattice is detectable. A second anhydrous modification of the acid also exists, the symmetry in this case being at the highest monoclinic. The hydrated acid forms monoclinic prismatic crystals of the space group C_{2h}^6, having $a = 6\cdot05$ Å., $b = 3\cdot57$ Å., and $c = 11\cdot9$ Å.; the elementary cell contains two molecules $(CO_2H)_2 2H_2O$. T. H. P.

2916. *Relation between the Acetaldehyde Molecules in the Space Lattices of Acetaldehyde-Ammonia and Metacetaldehyde.* **O. Hassel** and **H. Mark.** (Zeits. phys. Chem. 111. pp. 357–384, Aug. 25, 1924.)—Acetaldehyde-ammonia crystallises in ditrigonal scalenohedra of the space group D_{3d}^5; $r = 8\cdot17$ Å., $\alpha = 84° 50'$. The primitive elementary cell contains six molecules of acetaldehyde-ammonia arranged geometrically so that the aldehyde groups of the separate chemical molecules are adjacent, the tendency of these groups to polymerise being apparently detectable even in the crystal lattice.

Metacetaldehyde forms tetragonal crystals of one of the two pyramidal classes of the space group C_4^5 or C_{4v}^9; $a = 10\cdot34$, $c = 4\cdot10$. The elementary cell is space-centred and contains eight acetaldehyde molecules. Of these not more than four form the crystal molecule, the polymeride being thus not more complex than tetrameric. T. H. P.

2917. *The Structure of the Isomorphous Compounds* $(NH_4)_3ZrF_7$ *and* $(NH_4)_3HfF_7$. **O. Hassel** and **H. Mark.** (Zeits. f. Physik, 27. 2. pp. 89–100, 1924.)—The results obtained by the authors confirm Werner's theory of coordination, the essential of which is that in the crystal lattice the spheres of coordination are continued outwards. Each Pt atom in the lattice of K_2PtCl_6, for example, is surrounded in the first sphere by six Cl atoms in octahedral union, and then in a second sphere by eight K ions. Most of the complex compounds investigated belong to this type, and the two substances now dealt with have been chosen as belonging to a new type. Both salts crystallise in the cubical system like K_3ZrF_7, and the most usual form is an octahedron. Rotation diagrams were taken about [100], [110] and [111]. The edge of the cubical elementary body of $(NH_4)_3ZrF_7$ is $a = 9\cdot353$ Å.; the cell is simply primitive and contains four molecules; the same is true of the hafnium compound, $a = 9\cdot400$ Å. The following arrangement enables a satisfactory agreement to be obtained between the observed and calculated intensities: 4Zr(Hf) atoms with D_{3d}, 4F atoms with D_{3d}, 12 N atoms with C_{2v}, 24 F atoms with C_s. A figure in the original paper shows the arrangement. The elementary cube has a smaller cube centrally inside it, and complex ZrF_6 or HfF_6 ions are situated at alternate corners of the smaller cube, the other alternate corners being occupied by F ions. Each of the complex ions ZrF_6 consists of a zirconium ion surrounded by an octahedron, with six F ions of one kind distant 1·77 from the Zr and 2·5 Å. from each other; they form the first coordination sphere. Around each of the complex ions are six NH_4 groups, whose distances from the centre of the complex ion are 3·52 Å., and which are 2·71 Å. from the nearest F ion of the complex ion. Three of the six NH_4 groups lie on the edges of the larger cube, equidistant from one of its corners. The six can be regarded as the second coordination sphere, and bring about the union with the lattice of the F ions of the second kind, about which they group in exactly the same way as about the ZrF_6 ions. Finally, six F ions of the second kind form a third sphere about the selected Zr ion, with a distance 4·66 Å.

H. N. A.

2918. *Isotopes of Mercury and the Structure of the Green Line.* **R. Brunetti.** (N. Cimento, 1. pp. 185–207, July-Aug.-Sept., 1924.)—The components of the green mercury radiation from mercury vapour lamps have been photographed, using an echelon grating. The results of the measurements are compared with those of Janicki and Nagaoka. It is concluded that the absorption which occurs in the central component is not symmetrical and is sensitive to the conditions in the source. By adopting a constant error in the determination of the central component by Janicki and Nagaoka, their results are brought completely into line with the author's.

From Bohr's theory it is easy to calculate the change in wave-length to be expected for an isotope of slightly different mass. In the case of lead the change of wave-length calculated is about 80 times smaller than that observed. Assuming this factor, 80, to apply in the case of the green mercury line also, it is easy to calculate the masses of the isotopes to which the components of the line are due. There is good agreement with the hypothesis that isotopes of masses 197, 200, 202, and 204 are present, while both the author and Janicki and Nagaoka find a component which is in the mean position of the components due to masses 198 and 199. The relative proportions of the isotopes present are doubtful, those deduced from these experiments not agreeing with Aston's figures. A. Wh.

2919. *The Complexity of the Elements. Part II. Elements of Even Atomic Number.* **A. S. Russell.** (Phil. Mag. 48. pp. 365–378, Sept., 1924.)—The complexity of the elements of even atomic number is investigated on lines similar to those employed in Part I of this communication [see Abstract 2353 (1924)]. Even elements may be divided into four groups: (1) Simple elements with one mass number; (2) complex elements without odd isotopes, having two or three mass numbers; (3) complex elements with one odd isotope, having five mass numbers; (4) complex elements with two odd isotopes, having seven mass numbers.

These considerations, applying to the range from selenium to lead, are developed by assuming that the complexity is a periodic function of period 16 and by employing various empirical relationships existing for radio-active isotopes and ordinary elements. General rules similar to Fajan's rules, but wider in scope, are found to be applicable over the range studied. The masses of isotopes, in the order of their importance in the elements, are predicted for elements which have yet to be submitted to positive-ray examination. B. W. C.

2920. *The Dielectric in the Light of the New Theory of the Atom.* **G. Jacoby.** (Elekt. Zeits. 45. pp. 977–981, Sept. 11, 1924. Paper read before the Elektrot. Verein, Dresden, Dec., 1923.)—Gives a sketch of the Bohr theory of the atom, and shows its relation to chemical valency and combination and to the problem of electric conduction which take place in substances the atoms of which have a tendency to give up electrons, which then move under the influence of an electric field. With electronegative elements, on the other hand, the atoms of which have no such tendency, the electronic orbits are distorted by an electric field, so that the mean position of the electron with respect to the nucleus is shifted in the direction opposed to the field ; it is shown that this shift is very small, but the result is as if each atom has two opposite electrical poles and is thus polarised. Taking this into account, the value $k = 5r_0^3nN/4Z$ for the dielectric constant is arrived at, where r_0 is the radius of the electronic orbit, n the number of electrons in the outside layer of the atom, N the number of atoms in a cubic centimetre, and Z the atomic number of the element concerned. It is shown that the electrons of the inner layers can be neglected, as their shift is very minute, owing to the enormous field in which they move. The outer electrons are to be regarded as the polarisation electrons in non-conductors, besides being concerned in luminous radiation and in chemical union ; in conductors they can become conduction electrons. In the case of molecules, the values of k for the atoms are to be added. With pure water, however, it is necessary to assume the existence of two different kinds of molecule, with nearly equal numbers of each, if the dielectric constant, 80, is to be obtained in this way. Apparently one kind of molecule is regarded as very slightly conducting, while the other is an insulator, and the dielectric constant is calculated from the number of those of the second kind. It is shown that the theory includes Maxwell's idea of a current, or electric displacement, in the dielectric when introduced into a field. A semi-conductor or semi-insulator is supposed to contain electropositive atoms, which give off conduction electrons, as well as electronegative atoms, which have polarisation electrons and give the substance the properties of a dielectric. H. N. A.

2921. *Relationship between Atomic Numbers of Allied Elements.* **J. C. Thompson.** (Chem. News, 129. pp. 123–125, Aug. 29, 1924.)—An arithmetical interpretation of the Wedge Periodic Table (a modern form of Mendeléeff's Periodic Law) is developed on the lines of the Rydberg series equation for atomic numbers, special adaptations being indicated which are necessary to render it compatible with groups of elements known to be allied, but which will not give a Rydberg equation. A. B. C. L.

2922. *The Michelson-Morley Experiment.* **E. Brylinski.** (Comptes Rendus, 179. pp. 495–497, Sept. 8, 1924.)—M. le Besnerais has communicated to the author a correction according to which the author's explanation of Miller's data becomes invalid, and the displacement of fringes does not (to the second power of β) depend upon their breadth. He has also shown that Miller's results can be explained by the instrument being put out of adjustment by a rotation from the one position to the other. [See Abstracts 430, 765, 1398 (1924).] A. D.

2923. *The Selection Principle.* **C. N. Wall.** (Phil. Mag. 48. pp. 378–383, Sept., 1924.)—The selection principle which states that the azimuthal quantum number can change at most by unity in any interorbital transition is due to Rubinowicz. Bohr has obtained a restricted selection principle which excludes a zero change in angular momentum. But its rigorous development involves somewhat complex analysis, and the author in this paper shows that it may be derived in a comparatively simple manner, although not very rigorously, by aid of the Stokes-Thomson pulse theory. G. W. DE T.

2924. *Second Memoir on the Determination of the Curvature Invariant of Space-Time.* **L. Silberstein.** (Phil. Mag. 48. pp. 619–628, Oct., 1924.) See also Abstract 2203 (1924).

2925. *On Absorption and Dispersion in Bohr's Quantum Theory.* **R. Becker.** (Zeits. f. Physik, 27. 3. pp. 173–188, 1924.)—In accord with the new development of the quantum theory by Bohr, Kramers and Slater, the present investigation relates to the reaction between a quantum atom and an incident light wave from the standpoint of the resulting spherical wave. A continuity is thereby obtained between the phenomena of dispersion and absorption of the same kind as that rendered by the classical theory with the aid of elastically bound electrons. In particular it was found possible to derive in this way the dispersion equations of Ladenburg [see Abstract 1985 (1921)] and Kramers, although their validity was restricted to lines whose width is great in comparison with that conditioned by the classical damped radiation. The paper is entirely mathematical. H. H. Ho.

2926. *Relativity and the Measurement of a Moving Rod by a Fixed Observer.* **A. Lampa.** (Zeits. f. Physik, 27. 2. pp. 138–148, 1924.)—The length l of a moving rod, measured in a system which is at rest, is defined by Einstein as the result of observations by an observer in the resting system, by means of synchronous non-moving clocks, of the points in his system occupied by the ends of the rod at a definite time t; nothing is said, however, as to the appearance of the moving rod as seen by the non-moving observer; and the author has worked out an equation by means of which the length l of the moving rod for the fixed observer can be determined, if its velocity is known, by means of measurements of two angles and a base length in a similar manner to that in which the length of a non-moving rod can be determined when it is not possible to apply a measuring rod. The results obtained in the case considered are given in the table below:—

v/c	0	0·1	0·4	0·8	0·9	0·999	1
l ..	3	2·985	2·749	1·8	1·307	0·134	0

H. N. A.

2927. *An Exposition of Einstein's Restricted Relativity Theory.* **F. Dacos.** (Assoc. Ing. El. Liége, Bull. 2. Sér. 7. pp. 163–175, May, and pp. 244–260, July, 1924.)—This is a clear and simple exposition, based upon Einstein's Relativity Principle, 1905; Minkowski's Space and Time, 1905; N. Campbell's Modern Electric Theory, 1919; Eddington's Space, Time and Gravitation, 1921; Weyl's Space, Time, Matter, 1922; Becquerel's

Elementary Exposition of Einstein's Theory, 1922; Einstein's Theory of Relativity, 1922; Langevin's Principle of Relativity, 1922. G. W. de T.

2928. *Aberration of Light in Terms of the Theory of Relativity as illustrated on a Cone and a Pyramid.* **V. Karapetoff.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 223–236, Sept., 1924. Paper read before the Am. Phys. Soc., Washington, April, 1924.)—It is shown that it is possible to represent the path of a point moving with the velocity of light by means of a three-dimensional construction in Euclidean space, employing oblique coordinates with time as the third dimension. Thus, if a ray of light be propagated in the XY-plane and the angle between the path and the X-axis be determined by two observers, S and S′, who are in relative motion along the X-axis with a velocity q (expressed as a fraction of the velocity of light), it is shown that if the respective measured angles be δ and δ', then $\tan(\delta/2)/\tan(\delta'/2) = \cos(\pi/4 + \alpha/2)/\cos(\pi/4 - \alpha/2)$, in which $\sin\alpha = q$. This relation is interpreted geometrically by means of a cone in oblique X, Y, T coordinates. The T and X-axes are different for the respective observers, and the four axes, T, X, T′, X′, form a Lorentzian plane to which the Y-axis is perpendicular. The properties of the cone and the construction of a mechanical model are described. It is also shown that the relation between δ, δ' and α can be represented on a pyramid. [See also Abstract 2130 (1924).] J. S. G. T.

2929. *The Non-Metric Tensor Calculus.* **A. Buhl.** (Comptes Rendus, 178. pp. 1518–1519, May 5, and pp. 1801–1802, May 26, 1924.)—The author outlines very briefly the nature of his argument that, according to the non-metric tensor calculus, electromagnetism should not, as in the schemes proposed by Weyl and by Eddington, follow after gravitation, but should precede it. Electricity is more fundamental than matter, and it is as a consequence of the Euclidean electromagnetic equations that it becomes possible to derive from one and the same matrix both the metric formulæ and those of generalised gravitation. G. W. de T.

METEOROLOGY AND GEO-PHYSICS.

2930. *The Book of Normals of Meteorological Elements for the British Isles.* (Meteorolog. Office, Air Ministry, M.O. 236. Sect. 5. pp. 223–290, 1924.)

2931. *Distribution of Iron in Meteorites and in the Earth.* **L. H. Adams** and **H. S. Washington.** (Washington Acad. Sci., J. 14. pp. 333–340, Aug. 19, 1924.)—It is now generally agreed that the earth consists of an iron core surrounded by silicate rock. The principal reason for assuming the dense material in the interior to be mainly metallic iron is the analogy with meteorites. It has been suggested that a zone of mixed metallic iron and silicate rock, called pallasite, lies between the iron core and the silicate shell. This zone is supposed to be granitic near the surface and of basic (peridotitic) character below. Its existence is indicated by the manner in which earthquake velocity varies with depth. The velocity increases rectilinearly with the depth to about 1600 km. below the surface; thereafter it is almost constant for another 1400 km. Laboratory measurements show that velocity increases with pressure and hence with depth; also the velocity is much less in metallic iron than in basic silicate rock. Hence in the pallasite zone the increase due to depth is offset by the increased admixture of iron. Meteorites are classified into three main groups—siderites, almost wholly nickel-iron; siderolites, about equally composed of nickel-iron and silicates; and aerolites, almost all silicates. From the consideration that meteorites are fragments representing different parts of a whole, the earth is conceived as a body of composition which varies from nickel-iron at the centre to silicate rock at the surface. [See also Abstract 1341 (1923).] G. E. A.

2932. *The Rainfall Equation.* **K. Fischer.** (Meterolog. Zeits. 41. pp. 244–246, Aug., 1924.)—The fundamental equation (Rainfall = Run-off + Evaporation + Percolation) receives brief discussion, and modifications are suggested with regard to its interpretation in different climatic regions. W. A. R.

2933. *The Automatic Measurement of Atmospheric Pollution.* **J. S. Owens.** (Nature, 114. pp. 330–332, Aug. 30, 1924. Substance of paper read before British Assoc., Toronto, 1924.)—The atmospheric pollution has been measured for different cities with automatic recorders; from the results the mean diurnal variations in the amount of impurity present have been obtained for days of relatively high and low impurities respectively. London, Glasgow, and Rochdale show a minimum impurity in the early morning and a maximum between 9 and 10 a.m., with a secondary maximum occurring at about 4 p.m. Several peculiarities are shown in the curves for Blackburn and Stoke-on-Trent, which may possibly be attributed to local industrial conditions. Results obtained with the automatic recorder have been compared with those given by the dust counter; it is concluded that the results given by the former are trustworthy for comparative purposes when dealing with black particles. A. W. L.

2934. *A Simple Arrangement for Observation of the Optical Trouble of the Atmosphere—Application to the Estimation of the Definition of Images given by the Instruments.* **C. Gallissot.** (Comptes Rendus, 179. pp. 459–461, Sept. 1, 1924.)—After a brief description of the experimental arrangements, the observation of the optical troubles and the state of the atmosphere and undulation of the images is dealt with. In the latitude of Lyon the images are in the mean better in winter than in summer. The observations show that the period extending from the end of September to April is a period of regular and stable regime in opposition to the period spring-summer. The maximum altitude of the series appears, by systematic observation of the scintillation, to occur at two epochs of the year, February-March and September-October. These facts are in accord with the annual variations observed by Bigourdan. [See Abstract 1009 (1915).] A. E. G.

2935. *The 11-Year Sunspot Period and Temperature Variations in the Northern Hemisphere; Their Seasonal and Local Peculiarities.* **B. Droste.** (Meteorolog. Zeits. 41. pp. 261–268, Sept., 1924.)—The researches of Hahn, Abbot and others, and especially the work of Köppen and Mielke, indicated that there is an 11-year period in the average annual temperatures of terrestrial climates corresponding with the 11-year sunspot cycle, and that temperature maxima coincide with sunspot minima. In certain regions of our northern hemisphere diversity was found, but this could be eliminated by classing many regions together in zones or taking the annual averages for the whole earth.

Mecking, on the other hand, pointed out in 1918 (Ann. d. Hydrogr. u. Marit. Met. pp. 1–19, 1918) that local and also seasonal differences were to be expected; and his investigations showed that it is the winter variations of temperature which follow most closely the sunspot cycle, especially those of midwinter in Northern America and those of late winter and spring in Northern Europe. The North American temperatures show the "positive period-effect" (temperature maximum agreeing with sunspot minimum), but in North Europe and the Gulf Stream region as far as Spitzbergen, and in the Behring Sea, the effect is negative (temperature maximum agreeing with sunspot maximum).

The present paper is a continuation of Mecking's work. His methods are used and the extra-tropical regions of the northern hemisphere not dealt with by him are included. The deviations of temperature from the normal are shown in tables, the various stations being grouped according to latitude and to longitude, first those of America and then those of Europe, North Asia, and the Mediterranean region, including the Azores. A map is given showing the regions of positive and negative period-effect. The conclusion reached is that the 11-year period is confirmed throughout, the temperature variations corresponding with sunspot maxima and minima most regularly and strikingly in winter, while in summer and in the yearly averages the correspondence is much less marked. The period-effect is usually positive, and the centres of regions in which it is negative are near Hildebrandsson's "centres of action of the atmosphere." The effect increases universally with higher latitude and with more continental conditions. In the regions of negative effect the values are always small. These results of local variation are not therefore in contradiction with the general statement of Köppen that the mean temperature of the whole of the earth's surface varies inversely with the sunspot cycle. M. A. E.

2936. *The German Tide Predictor.* **H. Rauschelbach.** (Zeits. Instrumentenk. 44. pp. 285–303, July, 1924.)—A short history of tide prediction is given, with references to the work of Laplace, Kelvin, and Darwin, and the United States survey. The causes of tides are stated and the terms to be considered are given. The additional necessity for predicting the depth of water at any tidal port, as well as the times of high and low tide, for use in war-time and in case of threatened attack by submarines, is pointed out. Greater attention has been paid to the subject by all maritime countries.

A detailed illustrated description is given of the German machine for the observatory at Wilhelmshaven, made between the years 1915 and 1919. Preliminary descriptions appeared in the March number of "Annalen der Hydrographie" (1921) and in "Archivs der Deutschen Seewarte." Four illustrations are given of the gear showing the elliptical plates carrying twenty scales. The machine is a large one, 187 × 240 × 110 cms., with time scales showing 12 hours, and the tide scales of 20 or 10 mm. to 1 metre of water. Special provision has been made for taking up wear, and a device is used to give accurate heights of tides when less than 3 metres. A year's tides can be shown for any one harbour on a paper strip 50 cms. in width and 21,000 cms. length, giving a travel of 24 mm. for each hour, special metal-tipped glass tubes being used for the recording pens. It is claimed that this machine takes into account six factors instead of only four, as in previous instruments, a table of twenty terms and the corresponding daily advance being given to seven decimal places. By this means much greater accuracy is obtained. The maximum capacity of the machine, given the requisite number of observers, is a detailed prediction of times and heights of tides for 800 to 900 harbours in a year's working. The machine is motor-driven, and an expert observer can enter some 1400 tides for a year in 12 to 15 hours, including setting the machine; this would take an experienced calculator months of work. W. C. S. P.

2937. *Shore Waves.* **H. Jeffreys.** (Phil. Mag. 48. pp. 44–48, July, 1924.)—An analysis of the conditions inshore shows that the production of waves with very long crests approximately parallel to the shore is a second-degree effect, due to the height of the waves becoming comparable with the depth of the water. W. A. R.

2938. *Dispersion and Extinction of Seismic Surface Waves and the Structure of the Uppermost Earth Strata.* **B. Gutenberg.** (Phys. Zeits. 25. pp. 377–381, Aug. 1, 1924.)—From two previous investigations it could be shown [see Abstract 781 (1924)] that the surface waves of earthquakes spread out with varying rapidity at different parts of the earth's surface, and that normal dispersion prevails, *i.e.* long waves travel quicker than short. For further evidence the author has studied reliable data wherever obtainable, and the present paper contains a preliminary account with statistics of the deductions obtained. In Europe, Asia, America, Atlantic and Arctic regions layers of about 55–60, 50, 25, and 25 km. thickness respectively lie over other material, and these are somewhat denser and considerably more wrinkled. In the Pacific the latter is dense up to the surface, and its boundaries produce reflection and refraction of surface waves which weaken them rapidly. The results found are in excellent agreement with the theory of isostasy. The paper also contains a survey of the density relationships in the earth's crust on the assumption that below a depth of 60 km. no variations obtain. H. S. Washington's work is briefly referred to in this connection. H. H. Ho.

2939. *Heat Escape from Earth's Surface.* **J. R. Cotter.** (Phil. Mag. 48. pp. 458–464, Sept., 1924.)—The attempt is here made to determine mathematically the rate of sinking of a given geotherm after one of the periods of thermal revolution outlined in Joly's radio-active theory of mountain building. [Abstract 226 (1924).] W. A. R.

ASTRO-PHYSICS.

2940. *Pressure and Circulation in the Reversing-Layer of the Sun's Atmosphere.* **C. E. St. John and H. D. Babcock.** (Mt. Wilson Observat., Contrib. No. 278. Astrophys. J. 60. pp. 32–42, July, 1924.)—New values of over two hundred solar wave-lengths measured at Mt. Wilson by two independent methods, the arc wave-lengths adopted by the International Union and unpublished data on pressure displacements thought to be practically free from pole effect, furnish a basis for a determination of the pressure in the solar reversing-layer. The pressure in atmospheres $= (\Delta\lambda_2 - \Delta\lambda_1) \div (c_2 - c_1)$ where the c's are pressure coefficients and the

$\Delta\lambda$'s are differences in wave-length between the sun and the vacuum arc. A suitable choice of lines eliminated effects dependent on level in the sun's atmosphere, on motion in the line of sight, and on relativity. A pressure of 0·18 ± 0·06 atmospheres was found for the lower few hundred kilometres of the reversing layer. Heights, behaviour in the vicinity of spots, vertical convection, rotation, pressure, and data derived from flash spectra are discussed and correlated in a suggested scheme of the sun's atmosphere.

AUTHORS.

2941. *The Sun's Motion and the Mean Parallaxes of Stars of Different Apparent Magnitudes.* **F. H. Seares.** (Mt. Wilson Observat., Contrib. No. 281. Astrophys. J. 60. pp. 50–59, July, 1924.)—The mean parallaxes of stars of different apparent magnitudes calculated from parallactic motions with a constant solar speed do not agree with those derived from the luminosity and density functions. Although the quadratic exponentials used to represent the distribution of luminosity and density are subject to serious limitations, the mean parallaxes computed with their aid appear to be reliable within a small percentage to the seventh apparent magnitude. The inference is that the solar speed varies with the brightness of the reference stars, and a comparison of the two series of results indicates the relation

$$V_0 = 12{\cdot}9 + 1{\cdot}21\,m \qquad (m = 1 \text{ to } 7) \quad . \quad . \quad . \quad (18)$$

or

$$V_0 = 19{\cdot}4 + 2{\cdot}8\,\overline{M} \qquad (\overline{M} = -\,1{\cdot}9 \text{ to } +\,0{\cdot}7) \quad . \quad . \quad (16)$$

The second formula is in close agreement with the results of Strömberg's investigation in Abstract 461 (1923) which gave $V_0 = 18{\cdot}8$ km./sec. for 800 giants, and $V_0 = 31{\cdot}7$ for 415 dwarfs. Equation (16) therefore appears to hold to at least $\overline{M} = +\,4{\cdot}6$, the mean absolute magnitude of Strömberg's group of dwarfs. The lower limit of m in (18) can in consequence be extended to the twelfth or thirteenth magnitude without risk of serious error. With the aid of (18) revised mean parallaxes have been calculated from parallactic motions to $m = 13$ (Table IV). As compared with results found with a constant solar speed, the parallaxes of the brightest stars are increased by 25 or 30 per cent., while those of the eleventh to the thirteenth magnitudes are decreased by about the same amount.

AUTHOR.

2942. *On the Detection of an Effect of Rotation during Eclipse in the Velocity of the Brighter Component of Beta Lyræ, and on the Constancy of Velocity of this System.* **R. A. Rossiter.** (Astrophys. J. 60. pp. 15–21, July, 1924.)—Elements from a series of spectrograms taken at the Allegheny Observatory in 1907 and from seven series, comprising a total of 442 spectrograms, taken at Ann Arbor in the years 1911 to 1921, show that the velocity of the centre of mass of the system is constant and that elliptical motion is very well satisfied. Probably no third body exists, since no disturbance of the two-body system can be detected. The accompanying elliptic velocity curve, with radial velocities indicated by the large dots, shows how well elliptical motion is satisfied. A secondary oscillation confined to the region of the velocity curve extending 1·6 days on each side of the principal minimum (or centre of the eclipse of the small bright body by the large faint body) has been isolated from the orbital velocity and measured. It has been shown to be due to the velocity of rotation of the partially eclipsed smaller component, and is here termed the rotational effect. In Beta Lyræ it has a total range of 26 km. A graphical determination of this curve of rotational velocity from Shapley's light-elements of Beta Lyræ gives a duration of eclipse 40 per cent. longer than the spectroscope has shown and an amplitude correspondingly too great. Further investigation of this subject is under way. AUTHOR.

2943. *Some Results of a Spectrographic Study of the Algol System.* **D. B. McLaughlin.** (Astrophys. J. 60. pp. 22–31, July, 1924.)—One hundred and fifty-six plates taken in 1913, 1920, and 1923 with the one-prism spectrograph of the Detroit Observatory form the basis of this discussion. From plates taken within one month in 1923 orbital elements of the eclipsing system are determined. The value of $a \sin i$ is larger than in previous determinations. With these elements as standard, the velocity of the centre of mass is derived for other epochs by means of simple residuals. A period of about $1\cdot885$ years and a range of 20 km. are indicated for the variation of the velocity of the centre of mass of the eclipsing system, substantially in agreement with the determination by R. H. Curtiss. The rotational effect due to the rotation of the brighter star during the partial eclipse, discovered by Rossiter in Beta Lyræ, is investigated in Algol, and is found to have a range of 35 km., as shown in the diagram. Computation with Stebbins' light-elements gives only half the observed range of the effect, on assumption that $m_b = 2m_f$. Investigation of this rotational effect is suggested as a means of determining dimensions of other eclipsing systems. Agreement of form of computed and observed curves serves as a check on light-elements. Assuming equal periods of revolution and rotation of the bright star the dimensions of the eclipsing system are calculated. The total mass is $5\cdot67\odot$. Mass ratio is $m_b = 5\cdot0\ m_f$. Radii of the stars are: $r_b = 3\cdot12\odot$, and $r_f = 3\cdot68\odot$. Distance between centres: 10,522,000 km. Densities: $d_b = 0\cdot16$, $d_f = 0\cdot02$ ($\odot = 1$). Hypothetical parallax of Algol is $0''\cdot031$. Orbital motion is suggested as a possible cause of negative parallaxes of certain stars. AUTHOR.

2944. *Radiometer Measurements of Stellar Energy Spectra.* **C. G. Abbot.** (Mt. Wilson Observat., Contrib. No. 280. Astrophys. J. 60. pp. 87–107, Sept., 1924.)—The author employed the new type Nichols radiometer, $0\cdot5$ mm. wide, with the Coudé arrangement of the 100-inch telescope on Mt. Wilson. A mirror system of collimation and image-forming, with a 60° flint-glass prism, produced a spectrum of 43-mm. dispersion from $\lambda = 0\cdot437\ \mu$ to $\lambda = 2\cdot224\ \mu$. Radiometer deflections at various points in the spectra of the sun and nine bright stars were observed visually on a scale at 5 m. from the radiometer. The stars observed were β Orionis, α Lyræ, α Canis Maj., α Canis Min., α Aurigæ, α Tauri, β Pegasi, α Orionis, and α Herculis. Alpha Orionis gave maximum spectral deflections of 50 mm. Atmospheric transmission having been allowed for, as determined for Mt. Wilson by solar work, the results were reduced to normal energy outside the atmosphere through the intermediary of the Smithsonian solar observations of 1920 and 1922. The results are given in Table V and Fig. 4. Being of small weight for wave-lengths less than $0\cdot55\ \mu$, the radiometric results were supplemented by the visual and photographic photometry of Wilsing, Scheiner, Münch, and Rosenberg. Very satisfactory agreement appeared in overlapping portions of the spectrum. The combined results having been plotted, they were compared with the energy curve of the perfect radiator to determine the absolute centigrade temperature best agreeing with the measures. Ratios of total radiation of the stars and sun were determined, and the diameters of perfect radiators of temperature and emission equal to the stars computed. These diameters were compared with interferometer diameters and with Russell's theoretical diameters, and found to be of the same order of magnitude. Better values for these and much fainter stars are expected in 1924. **AUTHOR.**

2945. *Long-Period Variable Stars.* **W. M. Smart.** (Observatory, 47. pp. 267–276, Sept., 1924.)—The author sketches in a general manner the trend of recent investigations on long-period variables, and indicates the main results achieved, basing his paper on one of Merrill's [see Abstract 802 (1924)] on 600 variables with periods varying from 30 to over 500 days, though having a maximum about 330 days, and a range in light-cycle of as great as 9 or 10 magnitudes. In the case of 47 M*e*- or S*e*-type stars, the values of D (the difference between the radial velocities derived from the absorption and emission lines) are positive in 45 instances, and evidence is given that the star's true radial velocity is derived from the absorption lines and not from the emission. This evidence is partly derived from statistical investigations based on the sun's motion computed relative to the long-period variable group, using the absorption and emission lines independently, and partly from the direct confirmation from the double star χ Ophiuchi, whose components are of types M6*e* (a long-period variable) and K0. The author deals particularly with the two stars *o* Ceti [see Abstract 1749 (1924)] and χ Ophiuchi [see Abstract 1811 (1923)]. His general conclusions are: that there is a general but not a close dependence of D upon spectral type [see also Abstract 1740 (1924)] and also on the magnitude range during the light cycle; small displacements with range less than 5 magnitudes, great displacements with range over 7; that the apex of the solar motion is approximately the same from K- and M-stars as from the radial velocities of 133 variables, but these last show a much larger solar velocity relative to the group and also much larger residual velocities; and that both the solar speed and the average residual velocity decreases from M3*e* to S*e*, and in this show the reverse of the progression of velocities from B- to M-types. Here lies the difficulty of placing the M*e* stars in the scheme of evolution. The author agrees with E. Frost and Miss Lowater in ascribing the relative displacement of the bright lines to the periodic outflow of incandescent gases and vapours, and he considers that the variation in the maxima may depend on the speed with which the incandescent gas is projected and the different distances that it travels outward through the star's absorbing layers. **A. S. D. M.**

2946. *Henry Draper Catalogue*, **21*h*, 22*h*,** and **23*h*.** **A. J. Cannon** and **E. C. Pickering.** (Harvard Coll. Astron. Obs., Annals, 99. [272 pp.], 1924.)—A continuation of Harvard Annals 98 [see Abstract 2391 (1923)], being a table of 24,594 stars, which completes the Henry Draper Catalogue of total number 225,300 stars whose spectra have been classified. In this volume the general classification of the spectra is repeated in the Introduction, as in previous volumes. **A. S. D. M.**

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LIGHT.

2947. *The Light of the Night Sky.* **(Lord) Rayleigh.** (Roy. Soc., Proc. 106. pp. 117–137, Aug. 1, 1924.)—Photometric methods for examining the variations of luminous intensity in the night sky are described. A uranium salt rendered self-luminous by radio-activity was used as the comparison light. Three alternative colour filters were used, one of which approximately isolated the green auroral line. A red and a blue filter isolated the regions of the spectrum on either side of this line, excluding the line itself. The light of the sky thus seen was equalised with the standard by means of neutral tinted glasses. Colour differences were not perceptible, owing to faintness of the light. Records are given of systematic observations of the auroral light for fifteen months and of the other components for seven months. These show considerable variations, relative to the standard light and to one another. The variations are far too large to be explained by changes in atmospheric transparency. It is intended to continue the series of observations long enough to determine whether a connection exists between the auroral light and sunspot activity. So far the auroral light has been found to vary very little over the whole range of latitude from England to the Cape of Good Hope. The polar aurora is contrasted with the auroral light found over this range of latitude, which is conveniently called the non-polar aurora. The latter may be a phosphorescence phenomenon, the luminosity being excited by the sun during the daytime and carried round by the earth's rotation, as in the phosphoroscope. The light of the night sky is much richer in red, measured relatively to blue, than is daylight, in this respect approximating to the light of a ½-watt incandescent lamp. J. J. S.

2948. *Reflection from Moving Mirrors.* **F. Guéry.** (Rev. Gén. d'Él. 16. pp. 371–376, Sept. 6, 1924.)—Compares Lorentz's theory (C constant with reference to fixed ether), Ritz's (C const. ref. to source), Stewart, Thomson (C const. ref. to image), Tolman's (C const. ref. to mirror). There ought to be a difference of the order B^2 between Lorentz and Ritz for the Doppler effect. The Ritz theory is the only one which would explain negative results in the Michelson experiment in the absence of a Fitzgerald contraction and if light travelled in straight lines relatively to a frame moving uniformly with reference to the source. In Huyghens' construction on the Lorentz theory the spherical waves are those from the point of view of a fixed observer; to an observer accompanying the mirror, the angle of reflection would not be equal to the angle of incidence unless there were a Fitzgerald contraction. A. D.

2949. *On the Passage of Light through Transparent Plates.* **A. Schuster.** (Phil. Mag. 48. pp. 608–619, Oct., 1924.)—In explaining the optical effects observed under suitable conditions in light that has passed through transparent plates, it is the current practice to select certain groups of rays and to apply the principle of interference. The author now substitutes a more rational procedure, which discards the conception of rays and seeks guidance by following the wave-fronts. His object is to show the more general and effective character of this method, and as an illustration he takes the so-called interference effects observed in parallel light after its passage through two mutually-inclined transparent plates, Brewster's bands being a special case of the general problem. The investigation is entirely mathematical, and can be easily extended to the case of reflection. The author hopes to deal at a later date with the case where the two plates have not the same thickness or when a small difference of thickness is partly compensated by a third plate. H. H. Ho.

2950. *Calculation of a Thin Aplanatic Objective.* **S. Nakamura.** (Phys. Math. Soc. Japan, Proc. 6. pp. 2–11, Jan., 1924. In English. Japanese Journ. Phys. 2. No. 3–5. pp. 85–94, 1923. In English.)—The author discusses at some length various methods available for the calculation of objectives as above. The methods, employing Abbe's invariant and Coddington's invariables, are referred to as the continental and English methods respectively. These methods and others, along with those due to Yamada, are shown to be mathematically equivalent, the choice of method in any case being decided by the simplicity of numerical calculation. These methods have the common defect that they give no information as to the optical behaviour of the component lenses. The procedure developed by the author has, though it is only a small departure from the usual method, the advantage of giving information as to the optical behaviour of the components and the stability of their compensation. The paper, which deals with the problem mathematically, concludes with a series of examples. F. S. B.

2951. *A New Photoelectric Star Photometer.* **P. Guthnick.** (Zeits. Instrumentenk. 44. pp. 303–310, July, 1924.)—This is an improvement on an earlier instrument, and the photometer contains four interchangeable photo-cells in a cylinder, either of which can be brought into register opposite a window into the main telescope. Various coloured lights can be used for spectrographic determinations. Each cell kathode is connected in readiness through slip rings to the requisite negative potential of a battery of accumulators. Connections from a cell and to the Wulf electrometer are made automatically when the cell is revolved into position inside the cylindrical casing. The framework of the photometer is earthed, and the electrometer is carried on ball-bearing gimbals. Three stops of 20, 8, and 4 mm. diameter are fitted between the photometer and the telescope, limiting the field of view to 3′, 70″, or 35″ as desired. The capacity of the cell, connections, and electrometer can be accurately determined. Increased speed of observation is claimed, and failure of a series of observations, owing to a breakdown, is overcome by the multiple cell arrangement. W. C. S. P.

2952. *Demonstration of a Selenium Photometer.* **F. C. Toy.** (Phys. Soc., Proc. 36. p. 432 (with Disc.), Aug., 1924.)

2953. *Some Instruments for Detecting Infra-red Radiation.* **D. S. Perfect.** (Journ. Sci. Instruments, 1. pp. 321–329, Aug., and pp. 353–362, Sept., 1924.)—In this paper are considered the theory and construction of several instruments which were designed in connection with the detection of infra-red radiation in the course of an extended research. It is thought that, though some of these were abandoned for the specific purpose in view, they might be of interest in other connections. The instruments considered are (1) a strip galvanometer, (2) a thermal expansion instrument, (3) a thermometric balance, (4) a modified Paschen galvanometer, and (5) a thermojunction. **Author.**

2954. *The Rotation of the Plane of Polarisation of Electromagnetic Waves by an Asymmetric Tetrahedral or by a Spiral-shaped Molecular Model.* **K. F. Lindman.** (Ann. d. Physik, 74. 6. pp. 541–573, July, 1924.)—The apparatus for the production of the electromagnetic waves is described in a previous paper [Abstract 1449 (1923)], to which reference must be made for details. The "atoms" of the models consist of hollow copper spheres, radius 3·5 cm., and hence having a natural half-wave-length of 12·7 cm. The waves were sent through the models and subsequently tested for a rotation of the plane of polarisation. The spheres were placed at the corners of a cube, forming an irregular tetrahedron, as in Fig. 1, the connecting links being thin pieces of wood. The rotations were measured with the model in various positions with respect to the direction of the incident beam. The results are summed up in the following statements: The molecular model 1 rotates the plane of polarisation of electromagnetic waves 2 × 8·8 cm. long towards the right by a given amount, which depends on the orientation of the tetrahedron and varies between 0° – 5°. Experiments were made on the variation of rotation with wave-length, and it was found that for waves of length equal to those corresponding to the natural period of the resonators the rotation is zero, and reaches a maximum to the right for slightly longer waves and a maximum to the left for slightly shorter ones. Experiments were made on models of smaller dimensions with analogous results. A mirror image of 1, as shown in Fig. 2, rotated the plane to the left by an amount corresponding to the right-handed rotation of 1.

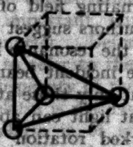


FIG. 1

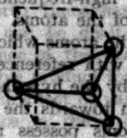


FIG 2

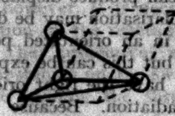


FIG. 3

Experiments on a rhombohedral model (Fig. 3) showed that the direction and amount of rotation now depended on the angle of incidence, while another "molecule" having four resonators at the corners of a regular tetrahedron showed no rotation of the plane of polarisation, even when the spheres were of unequal size. Experiments were also made with equal spheres arranged in right and left-handed spirals, 9 spheres (analogous to SiO_2) being the unit. A right-handed spiral rotated the plane to the right and a left-handed spiral to the left, similar variations to those previously obtained being observed with varying wave-lengths.

The results are in accord with the Bragg-Beckenkamp molecular model for SiO_2. The waves after passing through the spiral are slightly elliptically polarised, the rate of the axes of the ellipse being $1 : \sqrt{10}$ approximately. W. V. M.

2955. *Influence of a Magnetic Field on the Polarisation of the Resonance Light.* **G. Joos.** (Phys. Zeits. 25. p. 298, June 15, 1924.)—The author, with reference to his former paper [see Abstract 2052 (1924)], calls attention to the agreement in the views of three independent workers, Pringsheim, Breit and himself. J. J. S.

2956. *Polarisation of the Resonance Light.* **L. S. Ornstein** and **H. C. Burger.** (Phys. Zeits. 25. pp. 298–299, June 15, 1924.)—The authors refer to the paper by Joos [see Abstract 2052 (1924)], in which he endeavours to explain the polarisation of the resonance light that is emitted when a monatomic gas is exposed to radiation by polarised light. According to Joos, it must be assumed that the incident light exerts an orientating action on the gas atoms. The authors consider that it is improbable that the high-frequency alternating field of the light can produce displacement of the atoms. The authors suggest that the polarisation may be due to the atoms which emit the resonance light being in an orientated position with reference to the incident beam of light, but this can be explained by the hypothesis that only those atoms which have the right orientation towards the incident light can absorb the radiation. Because the atoms possess no marked rotation they send out again the energy received in the same orientated position in which the absorption took place. J. J. S.

2957. *A Contribution to the Extension and Improvement of the System of Secondary Wave-Length Standards.* **P. Wallerath.** (Ann. d. Physik, 75. 1. pp. 37–74, Aug., 1924.)—An experimental arrangement for the direct comparison of wave-lengths with the red cadmium lines by the interference method of Fabry and Buisson is described and investigated. It includes only quartz lenses, etc., so that the measurements may be carried out in the region of short wave-lengths. With the help of this apparatus, and taking into account the errors with respect to secondary standards which were emphasised at the Wave-length Congress at Rome, 1922, measurements were made on about 70 lines in all belonging to the spectral region 3466–7544 Å. By using a 12-mm. 5-amp. arc as a source of light the 30 stable lines of the region 3558–5341 Å. were added to the existing list of tertiary standards with respect to the Cd. 6438, which had been proposed as the standard wave-length by the congress. The measurements were made so as to provide substitution lines for the unstable secondary standards and partly to fill the gaps in the catalogue of the proposed secondary standards. Besides 8 wave-lengths of the cadmium vacuum arc spectrum in the region 3466–5086 Å., 32 lines of the Neon spectrum (region 5852–7544 Å.) were compared with the red cadmium line. The determination of the proposed standards in the ultra-violet part of the spectrum of iron from 3370 downwards has also been carried out. The extension of the measurements to the short wave-lengths as well as to the infra-red portions of the Neon spectrum is contemplated. W. V. M.

2958. *Certain Fundamental Problems in Photography.* **T. S. Price.** (Roy. Soc. Arts, J. 72. pp. 725–736, Sept. 5, *et seq.* 1924.)—In this general paper the following questions are among those considered: The special properties which makes gelatin particularly suitable as an emulsion medium. A complete answer to this question would have to deal with both the chemical and physical properties of gelatin, but in these respects our knowledge is incomplete. It is very doubtful whether gelatin has yet been obtained as a definite unitary product, although considerable progress has been made in this direction by Schryver, and the purest photographic gelatins probably contain varying amounts of degredation products or other organic impurities in addition to inorganic matter, which constitutes the ash. What is meant by a colloidal solution is dealt with at some length. It is the realisation that gelatin does not behave simply as a colloid, but has both acid and basic properties, which has brought some order out of chaos in recent years. It is shown that in processes where gelatin plays a part it is important to know the *p*H value. It is reasonably certain that the physical properties of a gelatin do not alone confer on it its photographic properties. The part which gelatin plays at the actual moment of precipitation of the silver halide is probably very important, but hitherto there has been very little published on the matter. Before this can be dealt with, however, it is necessary first to refer to the influence of the concentration of the reactants on the dispersity of the insoluble product formed. The "protective" action of gelatin is discussed. The effect of various substances on the swelling of gelatin is of importance in the process of washing the shredded emulsion in order to remove soluble salts. A. E. G.

2959. *The Energy liberated during Phosphorescence.* **A. A. Guntz.** (Comptes Rendus, 179. pp. 361–364, Aug. 11, 1924.)—The intensity of the phosphorescence of zinc and cadmium sulphides, described in a previous communication [see Abstract 2411 (1923)], is measured photometrically, and by a series of calculations the energy involved is evaluated, taking into account factors such as the varying sensibility of the eye with radiations of different wave-lengths. The energy liberated is comparable with that developed in a chemical reaction. It is shown that zinc sulphide may become energised a second time by immersion in liquid air, the first effect of which is to cause the disappearance of the phosphorescence. This phosphorescence, however, reappears on warming. With calcium sulphide no new absorption of energy occurs at low temperature. B. W. C.

2960. *The Characteristics of the Phosphorescence of the Rare Earth Elements in Phosphorescent Alkaline Earths.* **R. Tomaschek.** (Ann. d. Physik, 75. 2. pp. 109–142, Aug., 1924.)—Little has hitherto been known either of the character of the rare earths' emission or the emission mechanism. The rare earths give relatively sharp lines in the emission spectrum, and thus present a method for quantitative investigation. A historical survey of the subject is followed by details of preparation of the phosphorescent bodies. As bases, CaO, SrO, $SrCO_3$, $BaCO_3$, BaO, CaS, BaS, SrS, CaSe, and ZnS were used, and about 200 samples prepared with the rare earths praseodym, samarium, selenium, terbium and erbium. Terbium, with colourless salts, exhibits extraordinary phosphorescent power, a property which has only one analogy (SrSZn)

The results are in accord with the Bragg-Beckenkamp molecular model for SiO_2. The waves after passing through the spiral are slightly elliptically polarised, the rate of the axes of the ellipse being $1 : \sqrt{10}$ approximately. W. V. M.

2955. *Influence of a Magnetic Field on the Polarisation of the Resonance Light.* **G. Joos.** (Phys. Zeits. 25. p. 298, June 15, 1924.)—The author, with reference to his former paper [see Abstract 2052 (1924)], calls attention to the agreement in the views of three independent workers, Pringsheim, Breit and himself. J. J. S.

2956. *Polarisation of the Resonance Light.* **L. S. Ornstein** and **H. C. Burger.** (Phys. Zeits. 25. pp. 298–299, June 15, 1924.)—The authors refer to the paper by Joos [see Abstract 2052 (1924)], in which he endeavours to explain the polarisation of the resonance light that is emitted when a monatomic gas is exposed to radiation by polarised light. According to Joos, it must be assumed that the incident light exerts an orientating action on the gas atoms. The authors consider that it is improbable that the high-frequency alternating field of the light can produce displacement of the atoms. The authors suggest that the polarisation may be due to the atoms which emit the resonance light being in an orientated position with reference to the incident beam of light, but this can be explained by the hypothesis that only those atoms which have the right orientation towards the incident light can absorb the radiation. Because the atoms possess no marked rotation they send out again the energy received in the same orientated position in which the absorption took place. J. J. S.

2957. *A Contribution to the Extension and Improvement of the System of Secondary Wave-Length Standards.* **P. Wallerath.** (Ann. d. Physik, 75. 1. pp. 37–74, Aug., 1924.)—An experimental arrangement for the direct comparison of wave-lengths with the red cadmium lines by the interference method of Fabry and Buisson is described and investigated. It includes only quartz lenses, etc., so that the measurements may be carried out in the region of short wave-lengths. With the help of this apparatus, and taking into account the errors with respect to secondary standards which were emphasised at the Wave-length Congress at Rome, 1922, measurements were made on about 70 lines in all belonging to the spectral region 3466–7544 Å. By using a 12-mm. 5-amp. arc as a source of light the 30 stable lines of the region 3558–5341 Å. were added to the existing list of tertiary standards with respect to the Cd. 6438, which had been proposed as the standard wave-length by the congress. The measurements were made so as to provide substitution lines for the unstable secondary standards and partly to fill the gaps in the catalogue of the proposed secondary standards. Besides 8 wave-lengths of the cadmium vacuum arc spectrum in the region 3466–5086 Å., 32 lines of the Neon spectrum (region 5852–7544 Å.) were compared with the red cadmium line. The determination of the proposed standards in the ultra-violet part of the spectrum of iron from 3370 downwards has also been carried out. The extension of the measurements to the short wave-lengths as well as to the infra-red portions of the Neon spectrum is contemplated. W. V. M.

2958. *Certain Fundamental Problems in Photography.* **T. S. Price.** (Roy. Soc. Arts, J. 72. pp. 725–736, Sept. 5, *et seq.* 1924.)—In this general paper the following questions are among those considered: The special properties which makes gelatin particularly suitable as an emulsion medium. A complete answer to this question would have to deal with both the chemical and physical properties of gelatin, but in these respects our knowledge is incomplete. It is very doubtful whether gelatin has yet been obtained as a definite unitary product, although considerable progress has been made in this direction by Schryver, and the purest photographic gelatins probably contain varying amounts of degredation products or other organic impurities in addition to inorganic matter, which constitutes the ash. What is meant by a colloidal solution is dealt with at some length. It is the realisation that gelatin does not behave simply as a colloid, but has both acid and basic properties, which has brought some order out of chaos in recent years. It is shown that in processes where gelatin plays a part it is important to know the *p*H value. It is reasonably certain that the physical properties of a gelatin do not alone confer on it its photographic properties. The part which gelatin plays at the actual moment of precipitation of the silver halide is probably very important, but hitherto there has been very little published on the matter. Before this can be dealt with, however, it is necessary first to refer to the influence of the concentration of the reactants on the dispersity of the insoluble product formed. The "protective" action of gelatin is discussed. The effect of various substances on the swelling of gelatin is of importance in the process of washing the shredded emulsion in order to remove soluble salts. A. E. G.

2959. *The Energy liberated during Phosphorescence.* **A. A. Guntz.** (Comptes Rendus, 179. pp. 361–364, Aug. 11, 1924.)—The intensity of the phosphorescence of zinc and cadmium sulphides, described in a previous communication [see Abstract 2411 (1923)], is measured photometrically, and by a series of calculations the energy involved is evaluated, taking into account factors such as the varying sensibility of the eye with radiations of different wave-lengths. The energy liberated is comparable with that developed in a chemical reaction. It is shown that zinc sulphide may become energised a second time by immersion in liquid air, the first effect of which is to cause the disappearance of the phosphorescence. This phosphorescence, however, reappears on warming. With calcium sulphide no new absorption of energy occurs at low temperature. B. W. C.

2960. *The Characteristics of the Phosphorescence of the Rare Earth Elements in Phosphorescent Alkaline Earths.* **R. Tomaschek.** (Ann. d. Physik, 75. 2. pp. 109–142, Aug., 1924.)—Little has hitherto been known either of the character of the rare earths' emission or the emission mechanism. The rare earths give relatively sharp lines in the emission spectrum, and thus present a method for quantitative investigation. A historical survey of the subject is followed by details of preparation of the phosphorescent bodies. As bases, CaO, SrO, $SrCO_3$, $BaCO_3$, BaO, CaS, BaS, SrS, CaSe, and ZnS were used, and about 200 samples prepared with the rare earths praseodym, samarium, selenium, terbium and erbium. Terbium, with colourless salts, exhibits extraordinary phosphorescent power, a property which has only one analogy (SrSZn) in heavy metal phosphorescent bodies. The methods of preparation follow well-known lines. The emission was investigated by means of a spectrophotometer. The typical spectrum was photographed on specially sensitised plates for the determination of the wave-length. A Zeiss comparator served to measure the records. Either an iron arc with water cooling or an iron spark was used as exciting source for ordinary records, but a carbon arc with water trough and blue monochromatic filter screen was used for investigation of long wave-lengths. For other purposes a mercury-vapour lamp or aluminium spark were used. For kathode-ray excitement an aluminium window tube was used with an incandescent kathode, whereby the phosphorescent body (in small aluminium basins 1 cm. from the window) glows outside. In many cases the phosphorescence is of good intensity and duration at ordinary room temperature, but investigations were made at various temperatures. It was noted that the oxide phosphorescence was almost as bright as that of the sulphide and also the colour was noteworthy. Small and somewhat broader lines occur, and as these grow together they build up broad bands in the spectrum. By lowering the temperature the bands break up into groups of lines in many, but not in all cases. The precise definitions of the terms band, partial band, group and partial group are given. The experimental records for each test are given in detail in order of the phosphorescent powers of the substances. Notes on each are also included. S. G. B.

2961. *Technique of Solar Radiation Measurements in Various Spectral Regions* (*Permeability of Filters, Sensitiveness of Cells, Michelson Actinometer*). **C. Dorno, K. W. Meissner, W. Vahle.** (Meteorolog. Zeits. 41. pp. 234–239, Aug., and pp. 269–277, Sept., 1924.)—Review of investigations carried out with various types of filters and cells. E. F.

2962. *Faraday's "Magnetic Lines" as Quanta. Part II.* **H. S. Allen.** (Phil. Mag. 48. pp. 429–445, Sept., 1924.)—The treatment employed in Part I [see Abstract 358 (1922)] is extended to the consideration of more complex distributions, two current circuits being taken as a typical case to represent either two magnetons or two electron orbits. Incidentally, a mechanical model, of similar character to Maxwell's model of an induction coil, is described, which gives a very close representation of the electrical system of two current circuits. The quantum relations are applied to the general case of any number of current circuits, and it is shown that there is no difficulty in generalising previous results. It is pointed out that in this mode of formulating the energy of a system frequency plays the part of an additive quantity. In attempting to apply the result to the interpretation of Bohr's theory of spectral series, it is shown that Bohr's frequency relation $h\nu_r = \frac{1}{2}n'h\nu' - \frac{1}{2}nh\nu$ can be interpreted by taking the frequency ν_r of the emitted radiation as identical with that of a quantum tube or tubes, such frequency being characteristic of the system, both in its initial and in its final state. A section of the paper is devoted to a more rigorous method, due to C. G. Darwin, of applying the quantum conditions for the case of two current circuits. A. B. C. L.

2963. *The Experimental Fundamentals for the Measurement of Penetrating Radiations.* **W. Kolhörster.** (Zeits. Instrumentenk. 44. pp. 333–

349, Aug., 1924.)—Penetrating radiation is defined as all radiation with greater penetrating power and smaller absorption coefficient than the quickest known β-particles of radio-active substances. The investigations show that in the neighbourhood of the earth there are two chief components: the γ-rays from radio-active substances in the earth's surface layer, known as earth radiation, and secondly an atmospheric radiation, probably also of the γ-type, from beyond the atmosphere and known as height radiation. Owing to its extreme smallness, the radiation cannot be measured with certainty at the earth's surface. Tables showing the values of both radiation components are appended. For the measurement of the phenomenon two new mountings and types of Wulf electrometer have been devised and used successfully. In the first type a frame is fitted about the vertical axis of the ionisation cylinder (capacity 4 litres) which is fastened at only one place, namely the middle of the upper cylinder. In the second pattern the frame was screwed to a plate at the aperture of the observation microscope. This frame carried a special indicatory apparatus. The second arrangement eliminated all unwanted displacements. The displacements of the electrometer thread due to changing internal pressure cause an elevation or depression of the thread in a parallel direction, and hence no alteration of the electrometer reading is noted. No variation was shown over a range of internal and external pressure change-difference from − 200 to + 300 mm. of mercury. Temperature compensation is effected by choice of materials of manufacture, namely, quartz glass and nickel steel. As the opposing force to the electric impulsive forces, the bending elasticity of a thin quartz loop filament (rendered conducting) is used. The loop is fastened at both ends to a small plate. If the electrometer is charged, the loop stretches out, and the extension is duly recorded with a microscope objective containing a scale. The electrometer thread is observed at the same time. Details of dimensions of the electrometer are appended and a discussion of its sensibility. The apparatus is of little use for quick registrations, but is portable and good for slow records. S. G. B.

2964. *Dimensions of Einstein's Light Quantum.* **E. Marx.** (Zeits. f. Physik, 27. 4. pp. 248–253, 1924.)—Statistical treatment of radiation equilibrium led Burger and Ornstein to the value $\alpha\lambda^2$ for the cross-section of the light quantum, where α was a universal but to them unknown constant. It is shown how, from the classical theory, one may calculate from the vibration volume of the electron that $\alpha = 3/4\pi$. The absolute value thus found satisfies the interference and diffraction of light. [See Abstracts 1450 and 1451 (1924)]. E. H. B.

2965. *Structure of the Second Positive Group of Nitrogen. Part II.* **P. Lindau.** (Zeits. f. Physik, 26. 6. pp. 343–370, 1924.)—In Abstract 2773 (1924) a description is given of an apparatus for measuring the plates taken of the second positive group of nitrogen. This part gives tables of the wave-lengths of the band lines; these are then arranged into three series in two ways, "lengthways" and "transversely." Combination formulæ are then deduced. A. C. M.

2966. *Structure of Multiplets of Higher Degree.* **A. Landé** and **W. Heisenberg.** (Zeits. f. Physik, 25. 4–6. pp. 279–286, 1924.)—A multiplet is said to be of the "first degree" if only electrons having the lowest azimuthal quantum number (1 in Sommerfeld's notation, $\frac{1}{2}$ in the authors') contribute to the impulse-moment of the atomic trunk. [See Abstract 528 (1924).]

If the trunk possesses n_k more electrons in a path of quantum number $k > 1$, then the multiplets will still be of the first degree if the algebraic sum of these contributions to the impulse is zero—*e.g.* Na and K give the same type of spectrum as Li, presumably on this account. But if one of these outer electrons is bound as a *p*- or *d*-term, then multiplets of the second degree are formed, and so forth. Neon gives multiplets of the second degree; it is discussed in detail in the paper, and a "branch principle" is found which summarises the formation of multiplets. This is then extended. A. C. M.

2967. *Zeeman Effect in Strong Magnetic Fields.* **P. Kapitza** and **H. W. B. Skinner.** (Nature, 114. p. 273, Aug. 23, 1924.)—Using apparatus recently described [see Abstract 2595 (1924)], the authors investigated the Zeeman effect in intense magnetic fields which lasted for about 1/100 second. The source of light was an intense spark which took place with a coil of 5 mm. internal diameter, in which the field was produced by a very strong current, spark and field occurring simultaneously. From observations along the lines of force in a field of about 130,000 gauss, the magnetic splitting of lines is found to be similar to that obtained in ordinary cases. Some partial and complete cases of the Paschen-Back effect have been observed. In certain cases the field produced lines not present in the comparison spectrum, whilst in others the lines disappeared in the field. Lines produced in the field are shifted towards the red by varying amounts; this is considered to be a pressure effect. A photograph is given showing a separation of 3 Å.U. for doublets of Ca and Al. G. E. A.

2968. *Effect of Argon on Certain Spectra.* **R. C. Johnson** and **W. H. B. Cameron.** (Roy. Soc., Proc. 106. pp. 195–215, Aug. 1, 1924.)—The effect of helium upon the secondary spectrum of hydrogen, upon the Balmer series and upon some spectra associated with carbon, as well as that of the inactive gases upon the nitrogen after-glow, makes a study of the effect of argon desirable. The instruments used were a glass spectrograph giving a dispersion of 3·2 in. from λλ7000–3900, and a quartz spectrograph of dispersion 4 Å. per mm. at λ2100 and 16·5 Å. per mm. at λ3000. The Swan bands appeared brilliantly, to the exclusion of the Ångström bands, when a little of a carbon gas was present in high-pressure argon, providing hydrogen was absent. "Comet-tail" bands have not been observed in argon. The CH band at λ4315 was considerably modified by argon, but no changes were observed in the high-pressure CO bands, Deslandres' 3rd and 4th positive bands of carbon, or the cyanogen bands which could be definitely attributed to argon. In the case of oxygen, a small quantity of argon entirely suppressed the band spectrum. It diminishes the broadening of lines in the line spectrum of OI, and represses a number of lines in that of OII. Tables are given of the intensities of various lines with different conditions of excitation. The bands produced when a little sulphur dioxide is added to argon in a discharge tube are tabulated, but no other effect of argon on band spectra associated with sulphur has been observed. The line spectra of sulphur are also suppressed in argon. F. S.

2969. *The Spark Spectrum of Cæsium.* **L. A. Sommer.** (Ann. d. Physik, 75. 2. pp. 163–181, Aug., 1924.)—This was photographed, using an end-on tube containing helium at about 8 mm. pressure. The tube was heated up to about 220° C. and the cæsium vaporised. Parallel to the tube was a capacity of about 0·01 m.f.d., and a spark-gap was placed in series of about 15 mm. length. The lines were measured against helium and iron comparison lines. The lines are arranged into series and level schemes are given. [See Abstract 1912 (1924).] A. C. M.

2970. *Ultra-violet Absorption Spectra of Naphthol Derivatives.* **S. Komatsu, B. Masumoto and S. Kumamoto.** (Kyoto Coll. Sci., Mem. 7. pp. 287–290, June, 1924.)—Curves are given obtained from photographs of the ultra-violet spectra, produced according to usual methods, of substituted naphthalenes, notably α- and β-naphthols, α- and β-naphthyl methyl ethers and their ar-tetrahydro compounds, in alcoholic solution. The effect of the OH group and of H atoms on both narrow and broad absorption bands is more noticeable in the α-compounds than in the β-isomers. It is suggested that the difference between the absorption curves of α- and β-compounds should be attributed to the spatial disposition of the substituted groups in the naphthalene molecule.

A. B. C. L.

2971. *Magnetic Spectra for Iron and Nickel Wires.* **W. Arkadiew.** (Zeits. f. Physik, 28. 1. pp. 11–28, 1924.)—Short Hertzian waves are produced on parallel wires; differences in the electrical and magnetic properties of the material are produced depending on the wave-length of the oscillations employed. Thus various functions of these properties may be related to change of wave-length, and so "magnetic spectra" be produced. Magnetic absorption bands are deduced from values for the absorption coefficient. The permeability and spectra are investigated for iron wires of different diameters. It is shown that from the shape of these bands the characteristic functions λ_0, θ, and μ_∞ of the elementary magnets may be deduced. λ_0 is the value of the wave-length which gives a maximum value to $S' = \sqrt{\frac{\mu_\kappa}{\lambda}}$ [see Abstract 633 (1919)]; θ is a measure of the damping; μ_∞ is the value of the permeability when $\lambda \rightarrow \infty$. Detailed results are given for one sample of Swedish iron and for three of nickel. The author is led to identify the elementary magnet with the atom, and to assume that the single crystals of iron are magnetised to saturation. A. C. M.

2972. *The Second Positive Nitrogen Spectrum.* **E. Hulthén and G. Johansson.** (Zeits. f. Physik, 26. 4–5. pp. 308–322, 1924.)—Measurements of the bands 3536, 3755, and 3805 are given and combination formulæ deduced. A level-scheme is given to express the transitions involved in producing the heads of each band-group; this scheme implies at least five initial states and twelve final states. Common initial states are shown to occur for the bands 3371, 3577, 3805 ($n = 0$) and for the bands 3536, 3755 ($n = 1$).

By comparison with the formula of Kramers and Pauli for the energy of rotation of a dipole the relation $\frac{h}{2\pi^2 J_m^n C} = A - k.n - p.m$ was obtained, giving the influence of the nuclear oscillation and of the rotation of the molecule on the moment of inertia.

In conclusion, the impulse-moment of the electrons of the molecule seems to be unaffected by the oscillations of the nucleus. A. C. M.

2973. *The Quadratic Electrical Effect at the D-Absorption Lines of Sodium (Inverse Stark Effect.)* **R. Ladenburg.** (Zeits. f. Physik, 28. 1. pp. 51–68, 1924.)—The paper describes the effect of powerful electric fields on the absorption lines of sodium as observed by means of the Lummer-Gehrcke instrument. Previous work on this subject is briefly reviewed [see Abstract 1409 (1915)]. Details are included of the most suitable light source to employ for rendering the interference maxima, and of the absorption tube which enables electric fields up to 160,000 volt/cm. to be established in sodium vapour at 10^{-5} mm. pressure. Sections are devoted to the measurement of these fields and of the electrical effects on the D_1- and D_2-absorption lines, also their dependence on the field strength and polarisation phenomena. A final section is devoted to theoretical considerations based both on classical and quantum considerations. Both lines are found to be displaced towards the red to about the same extent. The component of D_2 perpendicular to the field is appreciably less displaced than the parallel one, and this *p*-displacement amounts to 0·025 Å. at 160,000 volt/cm., being proportional to the square of the field strength. This result affords a typical example of the purely unsymmetrical quadratic effect that is to be expected from the Bohr atomic theory with respect to lines similar to hydrogen when the external electric field is small compared with that of the nucleus electrons. The quadratic effect at the D lines approximates in magnitude and character to that deduced by Voigt on the classical electronic theory, in which the quasi-elastic potential is extended by the addition, $\phi = \frac{1}{2}kr^2 + \frac{1}{4}k'r^4$. H. H. Ho.

2974. *The Action of Electric and Magnetic Fields on the Ultra-violet Fluorescence Spectra of Iodine.* **O. Oldenberg.** (Zeits. f. Physik, 27. 3. pp. 189–194, 1924.)—(1) *Magnetic Fields.*—As was observed by Steubings in the visible iodine fluorescence, the ultra-violet emission (excited by Al 1854–62) shows a shifting of intensity towards the long wave-lengths in strong magnetic fields. However, no important diminution of total intensity was observed. The fluorescence spectra which appear on the addition of other gases are not affected by the magnetic field. (2) *Electric Fields.*—The ultra-violet iodine fluorescence is not affected by an electric field. In particular this has been verified with respect to the band 3460, which in previous work [see Abstract 2498 (1924)] is explained in terms of ionic recombination. The conclusions to be drawn with respect to the fundamental causes of emission are discussed.
W. V. M.

2975. *The Spectrum of Helium in the Extreme Ultra-violet.* **T. Lyman.** (Astrophys. J. 60. pp. 1–14, July, 1924.)—The introduction deals with the effect of the nature of the ruling of the diffraction grating on the intensity of spectra in the extreme ultra-violet and on the strength of ghosts. A method is given for producing a continuous spectrum extending to 900 A. The existence of the second enhanced series has been confirmed, and two members of the first enhanced series at 303·6 and

256·3 have been discovered. Seven members of the OS — *m*P series have been measured. The identification of the line at λ600·3 corresponding to the second resonance potential is still in doubt. A line at λ591·5, corresponding to a jump from an energy-level in the doublet system to the lowest level in the singlet system, has been discovered. The presence of a continuous spectrum extending from the limit of the OS — *m*P series is noted. The apparatus and methods are described. This section includes some remarks on oil-coated plates and on the probable advantages to be gained by spattering a speculum diffraction grating with silicon. AUTHOR.

2976. *Width of Lines in Arc Spectra.* **S. Procopiu.** (J. de Physique et le Radium, 5. pp. 220–224, July, 1924.)—In this paper the author studies by interference methods the variations in the width, with pressure, of the line in the Zn, Cd, Ca, Al arc spectra. The slit of a spectroscope is placed along the diameter of a system of interference rings. The rings are produced by means of a Fabry and Perrot interferometer using semi-platinised quartz plates. For each line examined the pressure is varied to give a visibility of the rings corresponding to a width of the line of 0·1 Å.

In each series the width of the lines increases with the numerical order of the series in qualitative agreement with Stark's hypothesis on the influence of the intramolecular field. Spark lines are wider when originating from the kathode; lines from a flame spectrum are wider than those from the arc or spark. These results may be intrepreted on the hypothesis due to Gouy. F. S. B.

2977. *Standard Wave-lengths and Regularities in the Spectrum of the Iron Arc.* **W. F. Meggers.** (Astrophys. J. 60. pp. 60–75, July, 1924.)—The wave-lengths of selected lines in the arc spectrum of iron form a system of secondary and tertiary standards whose accuracy in relative value can now be tested with the aid of the recent discovery of regularities in this spectrum. From the vacuum wave-numbers which represent standard wave-lengths in a selected group of multiplets the relative values of 27 sets of spectral terms are calculated to 8 significant figures. Among these terms occur combinations giving rise to 84 multiplets belonging to the triplet, quintet, and septet systems. About 800 spectral lines, ranging in wave-length from 2276 Å., to 9768 Å., and including most of the internationally adopted standards, are thus represented with considerable precision. Critical tests of the accuracy in relative values of such standards are made (1) from the recurrence of differences of wave-number, which should be exactly the same in all mutliplets involving one set of terms in common; and (2) from cyclical relations of multiplets in groups of four, such that the wave-numbers for any one of them may be calculated from those of the other three. It appears that most of the wave-lengths of lines in any one multiplet are correct in relative value to one part in 2,000,000 or 3,000,000 except in the ultra-violet, where errors as large as 1 part in 400,000 exist. The lines, which are easily shifted by pressure and exhibit "pole-effect," are seen to originate in electron transitions from the outermost orbits of the excited iron atom. These effects can be eliminated and the accuracy of standard wave-lengths increased by the adoption of the *iron arc in vacuo* as the source of secondary and tertiary standards. AUTHOR.

2978. *The Quantum Theory of the Continuous X-Ray Spectrum.* **G. Wentzel.** (Zeits. f. Physik, 27. 4. pp. 257–284, 1924.)—When kathode-rays strike an antikathode a continuous X-ray spectrum is produced, with a definite limit on the high wave-length side. Sommerfeld and Pauli have considered how Bohr's correspondence principle for line spectra can be made use of to explain this continuous spectrum. Mathematically the problem consists in a transfer from a Fourier series to a Fourier integral, from a periodic to an unperiodic system. The classical spectrum of a Kepler ellipse would consist of a series of equidistant lines stretching to infinity; on the other hand, the series limit of the Balmer series has a finite value. The correspondence principle correlates the intensities of the classical and quantum theory lines, and it may be said that it displaces the classical upper harmonics, without change of intensity, towards smaller frequencies. In a similar manner the continuous spectrum deduced from the classical theory, which would extend to infinity, is compressed to a sharp limit at $V_0 = eV/h$. Sommerfeld and Pauli, however, were not able to determine with certainty the law governing this shift. Kramers, on the other hand, does not consider the analogy between the X-ray continuous spectrum and the Balmer series. When a stream of kathode-rays strikes a metal the electrons, when they "collide" with the atoms, describe hyperbolic paths around the nuclei. The author assumes that similar quantum relations hold between these paths to those between the elliptical paths, which are concerned with the production of line spectra, and that the correspondence principle still holds; he works out a mathematical theory on this basis, and compares the results of the theory with the experimental results of Kulenkampff. For high frequencies a series of intensity curves, taken at different voltages from 7000 to 11,980 for platinum, show close agreement; and, while this is not the case for lower frequencies, this appears to be due to experimental difficulties. Curves for Pt, Sn, Ag, Cu and Al also show agreement between the new theory and experiment, both of which give curves for Pt which are concave towards the frequency axis, and for Al curves which are convex towards that axis. The theory for a very thin antikathode is worked out, and interesting results may be obtained by experiments along the lines indicated.

H. N. A.

2979. *Diffraction of X-Rays by Narrow Slits.* Part II. **B. Walter.** (Ann. d. Physik, 75. 2. pp. 189–194, Aug., 1924.)—In a previous paper [see Abstract 2787 (1924)] the author has dealt with the diffraction effects produced by the passage of a beam of homogeneous X-rays through a narrow slit (width 40 μ). In the present work slit widths from 5 to 2·5 μ have been employed; distinct diffraction bands, showing clear maxima and minima, have been obtained. From a knowledge of the dimensions of the apparatus employed and the distance apart of these bands the value of the wave-length of the K_α-radiation of copper has been determined and found to agree with the known value within 10 %.

A. B. W.

2980. *Reflection of X-Rays.* **N. Carrara.** (N. Cimento, 1. pp. 169–183, May-June, 1924.)—In this paper, which is mainly of a mathematical nature, a new type of reflection is described. It is also shown by an optical theory that there is a maximum of intensity in the bundle of

X-rays scattered from the plane surface of a crystalline or amorphous body hit by a bundle of X-rays. It is thought possible that an experiment can be carried out, with the exclusion of refraction, which will prove in a concrete manner the presence of this reflection of X-rays.

A. E. G.

2981. *Hardness Distribution of Scattered X-Rays.* **F. Dessauer and R. Herz.** (Zeits. f. Physik, 27. 1. pp. 56–64, 1924.)—In order to investigate the Compton-Debye effect [see Abstract 534 (1924)] the authors have devised an apparatus by means of which the hardness of the scattered radiation, produced by the incidence of primary X-rays on a spherical "scatterer," can be photometrically determined simultaneously in all orientations relative to the direction of the incident beam. The experimental results are in conformity with Compton's theory of scattering.

A. B. W.

RADIO-ACTIVITY.

2982. *Radio-active Disintegration Series. Part II.* **W. P. Widdowson and A. S. Russell.** (Phil. Mag. 48. pp. 293–306, Aug., 1924.)—[See Abstract 285 (1924) for Part I of this paper.] In the present paper reference is made to an experimental investigation of the minerals pitchblende and thorianite and in a preparation of radium, with the object of searching for an isotope of radon, thoron and acton expelling α-particles with an anticipated period of seventy minutes. The search proved unsuccessful. It is concluded that if this hypothetical emanation exists and expels α-particles, its period must be greater than four hours or less than four minutes; or that, if its period lies within the above limits, the number of atoms breaking up per second must be less than a value which lies between 1/140 for the higher limit of period and 1/2500 for the lower of that of a member of the radium series in pitchblende or in thorianite.

It is to be anticipated theoretically that there are three out of four possible radio-active series which have members of atomic number 86 emitting α-particles. The fourth, if it exists, should arise from an isotope of protoactinium having an atomic weight of 233 pass through the missing elements 87 and 85 and end in bismuth.

The principal isotopes of elements 91, 85, and 87 are calculated to be 233, 221, and 217 respectively. Elements 85 and 87 are probably simple.

A. B. W.

2983. *Primary β-Rays.* **H. T. Wolff.** (Phys. Zeits. 25. pp. 348–352, July 15, 1924.)—Primary β-rays are those in which electrons are emitted from the nucleus. The question is whether before emission these electrons move in paths conformable to the requirements of the quantum theory. Their paths must lie within the nuclear diameter, not exceeding 10^{-12} cm. radius. Sommerfeld's quantum calculations (Ann. d. Physik, 51. p. 1, 1916) give, under Coulomb's law, a circular path with a definite radius, but to bring the radius down to the required value the atomic number would have to be 139. Coulomb's law would therefore not work with a spherical nucleus; the increase of force, with diminishing distance from the centre, would have to be more rapid than Coulomb's law would indicate. But that law would work if the nucleus were disc-shaped, and that whether the electron were rigid or a Lorentz's electron. The conception of the disc-shaped nucleus suggests explanations of certain sequences in radio-active transformations. The answer to the question is in the affirmative. A. D.

2984. *The Mode of Action of the Pointed Electrode α- and β-Particle Counter.* **H. Geiger.** (Zeits. f. Physik, 27. 1. pp. 7–11, 1924.)—The pointed electrode counter greatly multiplies the primary ionising action of the charged corpuscles. In a counter with 2 cm. diameter a β-particle produces primarily about 50 ions, or 2×10^{-8} electrostatic units, while the resulting current rush will be from 0·1 to 1 unit, depending on the voltage employed, or the primary effect is multiplied by 10^7 or 10^8. The recent investigation of W. Kutzner is discussed [Abstract 2118 (1924)], and attention is called to the fact that the explanation given only accounts with difficulty for the working of the instrument without an end plate. An explanation is proposed which considers the factors which cause the sudden stoppage of the current rush to reside in the point rather than in the end plate, and an experiment is described on which this explanation is based. The pointed electrode is connected to a string electrometer, and earthed through a resistance, which is so high that little current flows through it during the time of the current rush into the point; the electrode is then shunted by a capacity several times as great as the combined capacity of the electrode and the electrometer, and it is found that the deflections in the two cases are roughly inversely proportional to the capacity, so that for each point discharge a nearly constant quantity of electricity flows. It follows that it is not the increase of voltage of the isolated system, produced by the rush of current, which stops the discharge, for in that case the deflection would be independent of the capacity. The pointed electrode as a general rule will only work after a certain preparation, for instance after having been raised to incandescence. It is suggested that a fine surface film is formed, with a high electrical resistance, so that when the ions produced by the α- or β-particle have started a discharge, with the help of the electric field, this surface film becomes charged, and the electricity does not flow away rapidly to the rest of the electrode. Thus the potential difference between the surface and the end plate rapidly falls, and the current stops very soon after it has started. The quantity of electricity flowing will depend chiefly on the capacity of this surface film and very little on the capacity connected to the electrode. H. N. A.

2985. *The Emission of β- and δ-Rays from a Metallic Film and the Relation to the Quantum Theory of Scattering of X-Rays.* **L. Simons.** (Phil. Mag. 48. pp. 250–258, Aug., 1924.)—The author has continued his investigation of the slow electrons, or δ-rays, produced when X-rays fall upon a metal plate, which form a group quite distinct from the true photoelectrons [see Abstract 101 (1924)]. He now makes use of the comparatively homogeneous fluorescent X-radiation from secondary radiators, consisting of a number of different elements, on which the very constant X-radiation of a Coolidge tungsten antikathode X-ray tube was allowed to fall. This secondary radiation was allowed to fall upon an extremely thin film of gold, supported on a plate of paraffin wax backed with lead in an evacuated chamber and connected to an electroscope. To reach the gold film the radiation had to pass through the aluminium bottom of the experimental vessel, which was evacuated, and then through a thin plate of carbon, the potential of which could be varied from − 20 to + 20 volts. At the lower voltages only the fast electrons passed from the gold to the carbon, and it was only when the voltage was positive that the slow electrons came over. Curves are given showing the relation between the current for different voltages, with the different radiators employed; these make it clear that the slow δ-rays are much more numerous than the fast β-rays. There would be strict proportionality between the β- and δ-rays emerging from the gold film if each were produced by quasi-independent X-ray beams, always of the same relative intensities as measured by the number of electrons associated with each, but differing in wave-length by 0·040 Å.U. as the spectrum is traversed, the δ-rays being associated with the longer wave-lengths. This is shown to be exactly the amount to be expected from Compton's quantum theory of the scattering of X-rays if the δ-rays are associated with the modified and the β-rays with the unmodified scattered X-rays. H. N. A.

2986. *The Range of the α-Rays from UI and UII.* **B. Gudden.** (Zeits. f. Physik, 26. 2. pp. 110–116, 1924.)—In order to test Geiger and Nuttall's formula, $\log \lambda = A + B \log R_0$, connecting the range R_0 in cm. with λ the disintegration constant in sec.^{-1}, it is important to determine the range where the disintegration constant is small, as in the case of UI. This is not possible by ordinary methods, but the author has studied the pleochroitic haloes, recently described by O. Mügge, in blue Wölsendorf fluorspar, and finds that they differ from the haloes of mica and hornblende, in which the α-rays deepen the colour throughout their range, the action depending on the velocity in the same way as the ionisation produced in air; only the range from RaC′, and perhaps from RaA, can be measured with satisfactory accuracy. With the Wölsendorf fluorspar, on the other hand, the coloration is confined to the end of the range, where the velocity of the α-rays has become small, while higher velocities actually bleach the original blue colour. The radio-active nucleus is surrounded with concentric dark, spherical shells, and in sections concentric rings appear, one for each of the radio-active elements concerned. The breadth of these lines depends mainly on the dimensions of the particle of radio-active material concerned. A figure shows the dimensions of the rings for UI, UII, Io, Ra, Po, RaEm, RaA and RaC, and three photographs show the actual observed haloes. The innermost ring is due to UI and UII, and the line is about twice as broad as those due to the other elements. It is possible to deduce the equivalent range in air in cm. for these two elements from the position and breadth of this ring, the results being 2·76 cm. for UII and 2·68 cm. for UI. Geiger's calculated values are 2·91 cm. and 2·53 cm., so that there is a large discrepancy. The uncertainty in the author's figures is less than 1 per cent. The life of UII is about fifty times as large, according to this, as was previously supposed. H. N. A.

2987. *Very Large Quantum γ-Rays and the Photoelectric Origin of the Natural β-Spectrum of Radium.* **J. Thibaud.** (Comptes Rendus, 179. pp. 165–167, July 21, 1924.)—The author has shown, in a previous paper, that the principal high velocity β-rays of the natural spectrum of radium C can be assigned to monochromatic γ-rays emitted by the substance, with the energies in kilovolts 605, 1123, 1241, 1420, and 1763 [Abstract 2122 (1924)]. He now measures the energies of the β-rays produced when the γ-rays of RaC fall on U, Pb, W, and Ag. In the following table the figures in the second line are the amounts of energy in kilovolts required to remove an electron from the K level, the remaining figures give the energies observed for the β-rays :—

U.	Pb.	W.	Ag.
117	89·3	69·5	25·6
1004	1034	1057	1100
1122	1151		
1650	1677		
	1755		

The 1755 energy lead ray comes from the L level, all the others from the K level, and in each case the sum of the energy required to remove an electron from the K level and the observed energy of a β-ray is approximately equal to the energy of one of the above γ-rays. H. N. A.

2988. *Absorption and Scattering of Gamma-Rays.* **E. A. Owen, N. Fleming** and **Winifred E. Fage.** (Phys. Soc., Proc. 36. pp. 355–366; Disc., 366, Aug., 1924.)—(1) The absorption and scattering of gamma-rays from radium filtered through 23 mm. of lead have been measured in magnesium, aluminium, zinc, tin and lead.

(2) On the assumption that the mean effective wave-length of the radiation employed is 0·021 Å., the experimental results are consistent with the following statements; (i) When gamma-rays traverse matter, the characteristic radiations of the absorbing medium are excited; (ii) the atomic fluorescent absorption coefficient of gamma-rays depends upon the wave-length of the incident radiation and the atomic number of the absorber according to the law $\frac{\tau}{\rho}\cdot\omega = K\lambda^3N^4$, which holds for X-rays; (iii) the radiations which accompany this fluorescent absorption are the characteristic radiations of the K, L, M . . . series of the absorbing elements; (iv) the absorption of gamma-rays in light elements is due almost entirely to scattering; (v) the pure atomic scattering absorption coefficient is proportional to the atomic number of the absorber; (vi) in addition to fluorescent and scattering absorption, a true absorption exists, the atomic coefficient of which is proportional to the atomic number.

(3) Compton's formulæ, deduced from his quantum theory of scattering, would account for the experimental results if the wave-length of the incident radiation were 0·020 Å. Jauncey's formulæ would require the wave-length to be 0·029 Å. AUTHORS.

2989. *On the Origin and Nature of the Long-Range Particles observed with Sources of Radium C.* **E. Rutherford** and **J. Chadwick.** (Phil. Mag. 48. pp. 509–526, Sept., 1924.)—Considerable difficulty has been found in determining the nature of the swift particles observed by Rutherford, using the scintillation method, in N and O, with radium C as the source (see Abstract 912 (1919)). In the present investigation it has been shown that the particles of 9·3 cm. range appear in equal amount in He, O, CO_2 and Xe. The same is true of the particles with range 11·2 cm., though the number of these is small, and so the evidence is not so definite. It is not possible to suppose that the particles are produced in helium by the disintegration of that gas. No evidence has been found of the 13·3 cm. range particles of Bates and Rogers, and the number of 11·2 cm. particles is less than they found; this is probably due to their having used absorbing plates of mica, which gave H particles. Both sets of particles, 9·3 cm. and 11·2 cm., were, however, observed in the same numbers as before (about 1050 per sec. per mg. of RaC of the short range and 190 of the long range in xenon), when sheets of silica and mica were placed immediately over the source. With copper foil it was found that good results could not be obtained, on account of irregularities in the thickness of all the foils obtainable. The numbers and ranges of the long-range particles were shown to be independent of the method of preparation of the active deposit. The source was placed on one side of a graphite plate, and a sharp shadow, due to the main α-rays, was cast on a zinc sulphide screen in CO_2 at reduced pressure; the pressure was then raised to atmospheric, and the scintillations due to the long-range particles observed. No scintillations occurred outside the previous shadow edge, so that either the long-range particles are emitted by the source, or their direction of emission from the gas molecules must be the same as that of the impinging α-particles. The magnetic deflection measured by the shadow method, and *in vacuo* by a slit method, showed definitely that the 9·3 cm. range particles come from the source. H. N. A.

2990. *Further Experiments on the Artificial Disintegration of Elements.* **E. Rutherford** and **J. Chadwick.** (Phys. Soc., Proc. 36. pp. 417–422, Aug., 1924.)—In previous papers [see Abstract 279 (1923)] the authors have shown that protons can be ejected from the nuclei of B, N, F, Na, Al and P by bombardment with α-particles, but no certain conclusions could be drawn in cases where the ejected particles had ranges less than 30 cm. in air. In the present experiments these particles were observed at right angles to the path of the incident α-particles, and the limit of the trustworthy range was thus reduced to 7 cm., or less in some cases. Disintegration was found in the case of the light elements Ne, Mg, Si, S, Cl, A and K, but not in the case of H, He, Li, C and O. The results with Be were doubtful. The following heavier elements failed to show the effect: Ni, Cu, Zn, Se, Kr, Mo, Pd, Ag, Sn, Xe, Au, U. Elements from Ca to Fe have not at present given conclusive results. The comparative ranges of the ejected particles suggest that the nuclei of the even-numbered light elements are stable, while those of the odd-numbered light elements are comparatively unstable. An estimate of the field of force within the atom is deduced from these ranges. AUTHORS.

HEAT.

2991. *The Wiedemann-Franz Law.* **A. Eucken and O. Neumann.** (Zeits. phys. Chem. 111. pp. 431–446, Aug. 25, 1924.)—According to the Wiedemann-Franz law, the expression $\lambda/\chi T$ is a constant for different metals, where λ is the thermal and χ the electrical conductivity, and T the absolute temperature. Marked departures from the law giving abnormally high values are given with badly conducting metals and alloys. It is concluded that the heat conductivity of badly conducting metals is contributed by two different components, one of which corresponds to the conductivity of non-metals or the so-called crystalline conductivity λ_k, and the other with metallic conductivity λ_m. The possibility of the differentiation of these two factors rests on the difference of their behaviour with temperature and with a change of the state of aggregation of the crystals, λ_k falling rapidly with rise of temperature and with increasing sub-division of the crystal structure, while λ_m only changes slightly. It is concluded, however, that at a temperature below about 30° abs. the value of λ_m, which is proportional to the specific heat of the electrons, diminishes to a very small amount, and the heat conductivity is determined by λ_k.

Measurements are made of the thermal and electrical conductivities of pure antimony and bismuth at 90° abs. and 273° abs. These metals show considerable deviations from the above law. By varying heat treatment the metals are obtained with varying size of crystal grain structure, which is measured after etching. The thermal conductivity falls markedly with decreasing grain size, while the electrical conductivity slightly increases. A formula is derived theoretically to show the relation between λ_k and size of crystal grains on the basis of temperature gradients at the boundary surfaces of individual crystals. The influence of crystal size is more marked at the lower temperature, at the temperature of liquid air the thermal conductivity of fine crystalline antimony being only half that with the coarsely granular crystals, while with bismuth the value is one-third. By extrapolating the values to an infinitely small grain size, results are obtained for the Wiedemann-Franz number which, except for a departure given by bismuth at 90° abs., correspond to the values given by good conducting metals. Similar results to those with the above metals are obtained with alloys of zinc and copper of varying grain size of crystal structure. Measurements made with powdered metals and with a column of compressed brass discs show an increasing ratio of thermal to electrical conductivity, with increasing fineness of division. This effect is attributed to the high electrical and low thermal insulation of the film of gas adhering to the particles, and the ratio is lessened by exposing to an evacuated space.

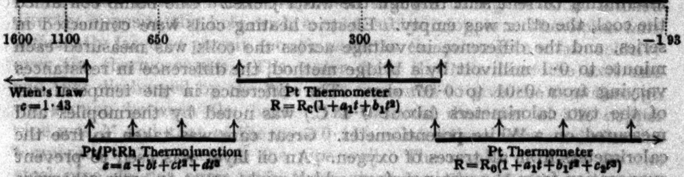
J. N. P.

2992. *Experiment on the Thermal Molecular Conductivity and Molecular Heat of Diatomic Gases at Low Temperatures.* **E. Schreiner.** (Zeits. phys. Chem. 112. pp. 1–67, Sept. 6, 1924.)—According to Nernst, polyatomic gases should, at low temperature, lose both the atomic energy of vibration and the energy of rotation. This was confirmed by Eucken [Abstract 517 (1912)] for hydrogen, which at 80° abs. behaved like a monatomic gas, and by Scheel and Heuse [Abstract 827 (1913)], who found that the molecular heats of carbon monoxide, nitrogen, oxygen and air were at 92° abs. by several per cent. (1 to 5) smaller than $C_v = 4 \cdot 96$ and also by Eucken's measurements of thermal conductivity. The author's experiments tend to show that the molecular heats of O_2, N_2, and CO are not further diminished when the gases are cooled from 90° down to 60° abs. His glass apparatus consists of two spheres, of 1-litre capacity, and a cooling tube containing a hot-wire manometer, a platinum wire 0·02 mm. in diameter. After evacuation the apparatus is filled with the gas, measured portions of which are then admitted into the tube, in which the rate of cooling is determined by a bridge arrangement. The experimental errors might amount to 3 per cent., but the molecular heats deduced deviated in extreme cases by as much as + 7·5 per cent. and − 6 per cent. from the assumed constancy. With certain improvements, the author believes, the apparatus should give reliable results.

H. B.

2993. *The Temperature Scale in Theory and Practice.* **F. Henning.** (Zeits. Instrumentenk. 44. pp. 349–366, Aug., 1924.)—The author effects a concise survey of the entire position regarding the temperature scale. The precise meaning of the terms degree and temperature as accepted to-day are set forth and discussed fully. The paper then deals with the theoretical foundations upon which the scale is built, discussing, *inter alia*, the Joule-Thomson effect for gases, Carnot principle, ideal gas equation, isothermals for various gases, etc. The Kelvin scale is compared with the gas scale in relation to the absolute zero value. Tables are given showing the difference between the thermodynamic and the gas scale at different temperatures. Radiation methods are then discussed theoretically. The second portion of the paper deals with the practical realisation of temperature measurement, and includes radiation, thermojunctions, and the Pt resistance thermometer. A diagram is given showing the temperature scale as determined by the Reichsanstalt, Berlin. The table shows the fixed points in the scale and indicates how they are standardised. A suggested scale is shown below which avoids a duplicate definition of temperature:—

Pd	Au	Ag	Sb	S	Zn	Cd	H_2O	H_2O	Hg	CO_2	O_2
1557	1063	960·5	630·0	444·55	419·4	320·9	100·0	0·000	−(38·87)	−78·51	−183·0



This scale was adopted by the Reichsanstalt, and is the conclusion arrived at from the survey in the paper.

S. G. B.

2994. *On Corresponding Temperatures for Solid Bodies.* **A. Brodsky.** (Comptes Rendus, 179. pp. 498–500, Sept. 8, 1924.)—After a discussion of Michaud's work it is shown, in the sense that Michaud defines corresponding temperatures, that the expression for C_v contains no individual constant, so that the specific heat for the same values of θ does not depend on the species of solid body, and the same applies to the entropy. Other formulæ, such as those of Nernst, Lindemann, and Debye, deduced on the quantum theory, lead to a like result. The examples given by Michaud have been utilised to verify the formulæ derived, and data for Al, Cu, Zn, Ag and Pb are included. H. H. Ho.

2995. *The True Specific Heats of Certain Salt Solutions.* **E. Cohen, W. D. Helderman** and **A. L. T. Moesveld.** (Zeits. phys. Chem. 112. pp. 135–140, Sept. 6, 1924.)—This paper contains a description of the experimental determination of the specific heats of solutions of calcium iodide (at 19° C.), ammonium nitrate (at 32·3° C.) and zinc sulphate (at 19° C.) for very different concentrations. For this purpose the adiabatic electrical calorimeter of Cohen and Moesveld was employed, this permitting an accuracy of 0·5 per 1000 [see Zeits. phys. Chem. 95. 305, 1920; 100. 151, 1922]. Details are also included of the preparation of the pure materials and of the precautions taken to avoid error. H. H. Ho.

2996. *Construction of Adiabatics for Large Temperature Changes and Variations of $C_p : C_v$.* **F. Magyar.** (Zeits. techn. Physik, 5. 9. pp. 404–405, 1924.)—Brauer's construction of adiabatics assumes that the ratio C_p/C_v is constant, an assumption which is invalid for temperature variations of over 1000°, as in gas and oil motors. Schule's data for the variation of C_p/C_v are adopted, the mathematical consequences deduced, and the modified adiabatic construction described. H. H. Ho.

2997. *Calorimetric Apparatus for the Measurement of Reaction Heats at High Temperatures.* **J. D. Davis.** (Indust. and Engin. Chem. 16. pp. 726–730, July, 1924.)—It was desired to measure the reaction heat of coal during carbonisation. This varies with the atmosphere used, being greater with nitrogen than hydrogen, and increases rapidly with the oxygen content of the coal. In the special calorimeter described the total heat supplied was about 8500 calories, but the reaction heat of the coal sample tested was of the order of only 30 calories per gramme. Two similar bomb calorimeters were arranged in a water-warmed jacket, which was maintained within ± 0·05° C. of the temperature of the calorimeters. Thermopiles operated a relay which controlled the alternating current sent through the water-jacket. One bomb contained the coal, the other was empty. Electric heating coils were connected in series, and the difference in voltage across the coils was measured each minute to 0·1 millivolt by a bridge method, the difference in resistances varying from 0·01 to 0·07 ohm. The difference in the temperatures of the two calorimeters (about 0·1° C.) was noted by thermopiles and measured on a White potentiometer. Great care was taken to free the calorimeters from all traces of oxygen. An oil layer was used to prevent evaporation from the water surface, which might cause an error otherwise of 40 calories, and equal stirring of both calorimeters was ensured, and thorough circulation of water through the jacket and cover provided. Blank tests without coal showed a greatest variation of 1·1 calories, or 0·013 % of the total heat input, but 3·6 % of the reaction heat to be measured. The heater tubes were of 0·47-cm. bore quartz tube, wound to 4 ohms with No. 24 constantan wire covered with alundum cement. This type of calorimeter is recommended by the author where small heats of reaction are to be determined at relatively high temperatures. The limiting temperature is about 650° C., as the resistance of constantan wire begins to vary quite widely above this temperature. W. C. S. P.

2998. *A Calorimeter for the Electric, Adiabatic Determination of Heats of Solution.* **E. Cohen, A. L. T. Moesveld** and **W. D. Helderman.** (Zeits. phys. Chem. 112. pp. 141–149, Sept. 6, 1924.)—A modification of the apparatus for determining the specific heat of solutions described by Cohen and Moesveld (Zeits. phys. Chem. 95, 305, 1920). The principle applied is that previously adopted by them for determining the heat of solution of metadinitrobenzol in ethyl acetate (Zeits. phys. Chem. 93, 385, 1919). The results obtained in a series of experiments are accurate to within about 3 per mil. E. F.

2999. *Heat Capacity of Aqueous Solutions of Hydrochloric Acid and Ammonia at Different Temperatures.* **M. Wrewsky** and **A. Kaigorodoff.** (Zeits. phys. Chem. 112. pp. 83–89, Sept. 6, 1924.)—The heat capacity of solutions of hydrochloric acid and ammonia at different temperatures was determined in a specially designed apparatus. The heating was effected by passing an electric current through a glass capillary spiral filled with mercury, and the current and voltage were accurately measured. Care was taken to avoid loss of hydrochloric acid or ammonia by vaporisation during heating. The results show that the specific heat decreases as the concentration of hydrochloric acid increases. This holds for all temperatures. On the other hand, with ammonia the specific heat has a well-marked minimum at a concentration of 25 per cent.

F. J. B.

3000. *Heat Transfer in Small Pipes.* **F. C. Blake** and **W. A. Peters, Jr.** (Indust. and Engin. Chem. 16. pp. 845–846, Aug., 1924.)—This is an account of some tests made on copper and steel pipes of $\frac{1}{16}''$ internal diameter through which water was forced at velocities ranging from 5 to 26 feet per sec. The water was heated by an electric current, using the pipe wall as the resistor. The temperature of the pipe wall was measured by means of a copper constantan thermocouple soldered thereto. To measure the temperature of the water small holes were drilled in the pipe wall about 5 in. apart, opposite the thermocouples, and a small thermocouple was inserted in a glass tube fastened directly opposite the hole with a split rubber stopper. The holes were sufficiently large to permit enough water to escape to give a fair velocity over the thermocouples. The water from the hole near the exit end and that discharged by the pipe were measured to give the flow through the section between the holes. The external diameter of the copper pipe was $\frac{1}{8}''$ and that of the steel 0·11″. Corrections were made for the temperature drop through the pipe wall. The results obtained for the steel pipe do not agree with those given by other observers, but the results for the copper pipe are more accurate. W. C. S. P.

3001. *Chemistry of High Temperatures.* **H. v. Wartenberg.** (Zeits. Elektrochem. 30. pp. 351–356, Aug., 1924. Paper read before the Deut. Bunsen Gesell., Göttingen, 1924.)—The main features are enumerated which come into consideration in conducting high-temperature chemical reactions such as reaction velocities, the application of the van't Hoff isochore, temperature measurements and the nature of refractory containers. Methods which have been applied or attempted for measuring equilibrium compositions and dissociation pressures include gaseous density determinations by the velocity of sound and optically by the interferometer and different types of manometers. In some investigations samples of gas were withdrawn by rapid cooling by the Deville hot-cold tube. In a further method for the study of gaseous equilibria at temperatures of 2000° C. to 3000° C. a catalyst is placed on an electrically heated wire or carbon rod surrounded by a cold containing vessel, when the composition of the gas is determined by the equilibrium at the temperature of the catalyst. High temperatures and pressures have been produced by the explosion of gases such as electrolytic gas, in the presence of which a second gaseous reaction has been studied. The pressures can be directly measured and the temperatures calculated from the heat of reaction and the specific heats. Data are compiled on heats of dissociation and equilibrium values at 5000° abs. of a number of gaseous molecules and compounds. At temperatures over 3000–4000° C. the electron gas becomes stable, and the chemistry of atomic combination passes into that of atomic ion-electron combination, and the affinity of the free electron is the ruling factor. The temperatures at which gases become luminous can be determined from the heat of dissociation of the electron, derived, as shown by Saha, from the ionisation potential and the estimate of Lenard that luminosity is attended by the ionisation of about 0·01 — 1 % of the total gas. Sodium vapour becomes luminous at about 2000° abs., while for air at least 4000°–5000° is necessary. Very high temperatures, up to estimated values of 10,000°, are obtained in explosion waves. At the meeting-point of two oppositely directed detonation waves still higher temperatures are produced.

J. N. P.

3002. *Oxides, Metals, and Carbides at High Temperatures.* **O. Ruff.** (Zeits. Elektrochem. 30. pp. 356–364, Aug., 1924. Paper read before the Deut. Bunsen Gessel., Göttingen, 1924.)—Discrepancies in earlier measurements of volatilising temperatures are referred to, and the difficulties attending high-temperature measurements are discussed. In the case of oxides, the main difficulties arise from reaction with gases or the containing vessel, which is generally ultimately of carbon. This interaction particularly applies at high pressures. With most refractory oxides, such as magnesia and lime, the m.p. cannot be reached in contact with ordinary compressed carbon, on account of the formation of free metal, which forms directly or by the dissociation of the carbide first formed, and then volatilises. Alumina and zirconia are somewhat more resistant against attack by carbon. For small scale furnaces tungsten foil tubes have been employed as heating material.

Determinations of volatility are made in the present work by ascertaining the loss of weight of the body when exposed for definite intervals in an electrically-heated tube, the temperature of which is determined optically. The values found for a large number of elements, oxides and carbides are tabulated, together with their melting-points. It is shown that, in general, an elevation of melting- and boiling-points of a compound above those of its components is only possible where a high affinity is present, as with oxides of lithium, magnesium, yttrium, and zirconium.

The application of a relation of the following form is investigated; $\log p = 0{\cdot}2184 \frac{\lambda_s}{T_s}\left(1 - \frac{T_s}{T}\right)$, where λ_s is the heat of volatilisation at the boiling-point T_s, and p is the vapour pressure in atmospheres. Graphs are plotted to show the relation between $\log p$ and $1/T$. On extrapolation to zero values of $1/T$, most of the metals and compounds give a value for $\log p$ converging to between 5 and 6·5. This corresponds to a value of the Trouton constant λ_s/T_s of 23–30. Marked departures occur, however, in the case of the alkaline earth metals, and the oxides of silicon and aluminium. A study is made of the solubility of carbon in iron at high temperatures and of the equilibrium in the reaction between lime, carbon, and calcium carbide. The state of equilibrium prevents the complete elimination of CaO from CaC_2 as ordinarily prepared. A eutectic containing 30 % CaO is found to be formed which melts at about 1630° C. At pressures below 50 mm. CaC_2 can no longer be obtained from CaO and C, as this is below the dissociation pressure of CaC_2 at the temperature of reduction. J. N. P.

3003. *Vapour Pressures and Composition of Vapour of Aqueous Solutions of Hydrochloric and Hydrobromic Acids at Different Temperatures.* **M. Wrewsky, N. Sawaritzky** and **L. Scharloff.** (Zeits. phys. Chem. 112. pp. 97–108, Sept. 6, 1924.)—The vapour pressure and composition of the vapour phase of hydrochloric acid and hydrobromic acid was determined over a range of temperatures. The determinations were made by streaming air through the solutions, absorbing the acids in caustic soda. The solutions were maintained at a constant temperature in a thermostat. The results show a very rapid change in the composition of the vapour accompanies a small change in concentration of the solution. F. J. B.

3004. *Relative Brightness of Black Body Radiation at the Melting-Points of Gold and Platinum.* **F. Hoffmann.** (Zeits. f. Physik, 27. 5–6. pp. 285–304, 1924. From the Reichsanstalt.)—If H_1, H_2 are the brightnesses of black body radiation for wave-length λ at the temperatures T_1, T_2, then

$$\log H_2/H_1 = \{1/T_1 - 1/T_2\}\cdot c/\lambda.$$

If the lower temperature T_1 can be fixed by the gas thermometer, then the radiation formula may be employed to obtain higher fixed points which are not practicable with the gas thermometer. The author chooses the melting-point of Au for the lower temperature, *viz.* 1063° C., as measured by the gas thermometer. He has previously employed this radiation method to fix the melting-point of Pd (1557°) [Abstract 116 (1920)], and in the present paper the work is extended to the melting-point of Pt. An iridium resistance furnace was used as source of radiation, and the brightnesses measured by a König-Martens spectrophotometer in the red, yellow and green spectral regions. The furnace contained a fixed iridium-ruthenium, iridium thermocouple, and as the temperature of the furnace was raised, the thermoelectric force was recorded simultaneously with that of a similar couple with a piece of Pt or Au wire separating the elements. The furnace was then maintained at the temperature indicated by the fixed couple when the circuit of the other couple was broken by the melting of the wire. The most probable value of the melting-point from all observations is 1771 ± 2° C. The table shows a comparison of melting-point temperatures by various observers, taking $c = 14{,}300$ and the melting-point of Au as 1063° C. :—

	Nernst and Wartenberg, 1906.	Waidner and Burgess, 1907.	Holborn and Valentiner, 1907.	Hoffman and Meissner.
Au	1063	1063	1063	1063
Pd	1553	1553	1576	1557
Pt	1764	1766	1779	1771

L. L.

3005. *Physical Foundation of the so-called Reciprocal Theorem.* **W. Jazyna.** (Zeits. f. Physik, 27. 4. pp. 254–256, 1924.)—It is a physical necessity that for systems which fulfil the condition $C_v = f(T)$ the zero pressure isobar $p = 0$ in the S-T diagram coincides with the entropy axis $T = 0$. The equation $p = T\phi(v) + \psi(v)$ exhibits a formal analytical criterion, and the reciprocal theorem is an essential and the equation $p = T\phi(v)$ a general criterion of the equations of state in question.

E. H. B.

3006. *The Flow of Compressible Fluids, treated Dimensionally.* **W. N. Bond.** (Phys. Soc., Proc. 36. pp. 367–378; Disc., 378, Aug., 1924.)—The method of dimensions treatment that is applicable to the pressure gradient at a point in a system through which non-compressible fluids of finite viscosity are passed is in this paper extended by means of the thermodynamical equations for gas flow to the case where appreciable changes in density of the fluid occur, but where no heat passes across the walls of the system. The theory is developed in detail only for the case of flow through a straight parallel-walled tube. The theory is then tested by means of experiments in which water and air at high velocities passed through small tubes. The air in some experiments had a velocity of more than two-thirds of the velocity of sound in the air. The possibility of errors due to moisture, pulsating flow, heat conduction through the walls, and proximity to the entrance to the tube is considered experimentally and by approximate calculation, and the errors are shown to be small in the present experiments. An error of moderate amount is, however, found, and attributed to the partial neglect of the variation of the variables over the transverse section of the tube. The value of the error varies in the way it might be expected to do, and is of the order that is expected by other considerations. AUTHOR.

3007. *Supplement to a Previous Paper: "On the Theory of the Thermodynamic Phase Boundary Potentials."* **E. Abel.** (Zeits phys. Chem. 112. p. 206, Sept. 20, 1924.)—The author is indebted to P. Gross for pointing out that in § 3 of the above paper [see Abstract 2630 (1924)] his assumption on infinite dilution of a distribution equilibrium resulting from the summation of the corresponding separate equilibria need not be generally valid. He now emphasises that the conclusions drawn in § 3 arise only in cases where the extrapolation employed is valid.

H. H. Ho.

SOUND.

3008. *Auditorium Acoustics.* **F. R. Watson.** (Frank. Inst., J. 198. pp. 73–83, July, 1924.)—To secure satisfactory loudness and an acceptable time of reverberation in auditoria of different sizes it is here proposed that the average absorption per unit area should be kept constant. This leads to two relations that accord closely with conditions found in auditoria that are considered satisfactory, *viz.* that the time of reverberation should vary with the cube root of the volume, and that the energy output of the source for the best results should be proportional to the total area of the surfaces in the room. Further experiments on rooms of different sizes are desirable.

The time of reverberation is more important than the loudness, as the ear is sensitive over a wide range of intensity. The formula

$$t = 0\cdot75 + 0\cdot375 \sqrt[3]{\text{volume in cu. ft.}}$$

is deduced from a number of data for different halls as giving the acceptable time of reverberation in seconds when no audience is present. G. A. S.

3009. *Note on Electrically-maintained Tuning-forks.* **D. W. Dye.** (Journ. Sci. Instruments, 1. pp. 340–341, Aug., 1924.)—Various factors affecting the frequency of a tuning-fork, such as the effect of the base and want of balance of the prongs, are discussed, use being made of the nodal surfaces or lines in the vibrating system. AUTHOR.

3010. *Electrically-maintained Tuning-forks: Some Factors affecting Frequency.* **A. B. Wood.** (Journ. Sci. Instruments, 1. pp. 330–339, Aug., 1924.)—A brief outline is given of the various factors affecting the frequency of electrically-maintained tuning-forks. The importance of damping is discussed, and it is shown that the *direct* effect on frequency is negligible, although damping serves as an indicator of other factors which affect frequency. In this connection, the relative importance of want-of-balance of the prongs and antinodal vibration of the base are estimated. It is shown in a particular case that the damping of a perfectly balanced fork is about 90 per cent. of that of the same fork with the prongs badly out of balance. The variation of damping with amplitude, with the load on the base of the fork, and the amount due to spring contacts are also examined. It is shown also that the weight of the base of the fork has an important influence on the frequency. The general question of reaction of external systems on the vibrations of a fork is considered and illustrated by means of an electrical analogy, using loosely coupled oscillatory circuits. The effect of amplitude on frequency and the influence of spring contacts are also discussed, a brief reference being made in conclusion to other factors affecting frequency. AUTHOR.

3011. *Sensitive Flames and Apparent Pressures.* **C. Barus.** (Science, 60. pp. 137–138, Aug. 8, 1924. Advance note from a report to the Carnegie Inst., Washington.)—By use of an interferometer U-gauge, it was sought to observe the acoustic pressure due to vibration of the gas within the quill tube, at a fine jet of which the sensitive flame occurred.

The flame was very sensitive, but no acoustic pressure could be observed. But there were *apparent* pressures in the flame itself. It is thought this may be due to the increased viscosity due to the high temperature of the flame. E. H. B.

3012. *Theory of Hearing.* **H. Hartridge.** (Nature, 114. pp. 243–244, Aug. 16, 1924.)—The author first expresses his agreement with the letters by R. Paget and G. Wilkinson under the above heading (Nature, 114. p. 87, July 19, 1924). It seems that, even if E. W. Scripture were right in stating that the movements of the vocal cords cannot be analysed, he is not justified in concluding that the aerial vibrations thus set up are not analysable either. The author believes there is unassailable evidence that such a conclusion would be wrong, because all workers in this field, from Helmholtz and McKendrick to Miller and Bevier, are in agreement as to the success of such analysis.

It is then pointed out that, in addition to the question of the damping coefficient of the ear resonators, raised by G. Wilkinson, two additional factors are involved in any attempt to determine the physiological behaviour of the ear, namely (1) the *least amplitude* of vibration of resonators of different pitch which will just cause noticeable stimulation of the corresponding hair cells, and (2) the *least perceptible difference* between the amplitudes of the resonators set up by two immediately successive tones—in other words, the *absolute* and *difference* thresholds respectively.

Finally, the author, also a physiologist, cannot agree with E. W. Scripture's suggestion that the resonance theory is unthinkable to those who work with delicate human tissues; neither can the author take seriously the proposal that the resonance theory be abandoned and Scripture's theory substituted. The resonance theory has passed every test to which the author has so far put it. Why, then, think of abandoning it? It is also regretted that Scripture is not as familiar with resonators as he apparently is with delicate human tissues. E. H. B.

3013. *Sound Transmission.* **L. Gazaud.** (Comptes Rendus, 179. pp. 284–285, July 28, 1924.)—Observations made at L'Étoile Station, near Marseilles, during a series of explosions enabled some conclusions to be reached regarding the existence of *zones of silence.* Vertical transmission is ruled out, and only horizontal transmission in the troposphere comes into question. It is concluded that the zone of direct audition around the origin of the sound is of very limited extent, and that the succeeding zone is alternately a zone of sound or silence according to the state of the sky—that is, according as there is or is not a bank of suitable cloud to collect, concentrate, and reflect the sound. W. A. R.

3014. *Sound Transmission.* **Rothé, Lacoste, Bois, (Miss) Dammann and (Mrs.) Hée.** (Comptes Rendus, 179. pp. 339–342, Aug. 4, 1924.)—The results obtained on the Mintrop seismometer at Strasburg in connection with the La Courtine experiments are given. These indicated complete correspondence between the results of calulation and observation. The speed of propagation found was exactly that of the first waves of natural quakes, as observed at short distance. W. A. R.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

3015. *A Possible Solution of the Maxwell Equations.* **F. J. v. Wiśniewski.** (Zeits. f. Physik, 27. 2. pp. 102–117, 1924.)—It is shown that the Maxwell differential equations for the electromagnetic field of an accelerated electron admit of a solution in which the electron emits no energy. It is assumed that the dependence of the field on the time is expressed only in terms of the coordinates ξ, η, ζ of the electron. This solution corresponds to the electron orbits in the interior of the atom, from which, according to Bohr, no energy is radiated. The paper is mathematical throughout. H. N. A.

3016. *Dielectric Properties required for Maxwellian Radiation.* **A. Press.** (Phil. Mag. 48. pp. 581–585, Sept., 1924.)—The author shows that, quite apart from the two curl equations of Maxwell's electromagnetic theory, general dynamical considerations lead to the conclusion that the values of the μ and k coefficients should in all cases be greater in the case of zero frequency systems than in the case of radiation manifestations such as light and Hertzian waves. Also that when the curl equations are taken into account the electrical refractive index should not be expected to agree with the optical determinations. This result is in agreement with the well-known experimental fact that the dielectric constant determined by experiments with light waves always comes out smaller than when determined by the charged condenser method.

In view of these results, the author calls attention to the work of C. Gutton [see Abstract 1461 (1900)], who found that the electrical refractive index for ice, for example, decreased progressively with increasing wave-length, approaching more and more nearly the value obtained by J. A. Fleming for a dry prism of ice when subjected to Hertzian waves. As to the self-induction and capacity coefficients in the effective values of μ and k, our conceptions of these constants must necessarily be altered. As for the power factor of an oscillating system, it must always be less than 0·5. G. W. de T.

3017. *Generalisation of the Rayleigh Reciprocal Theorem.* **J. R. Carson.** (Bell System Techn. J. 3. pp. 393–399, July, 1924.)—The theorem was stated in the language of electric circuit theory by Rayleigh in his Theory of Sound, Vol. I, p. 155. The author states it in a form represented by the equation

$$\sum_{j=1}^{n} V_j' I_j'' = \sum_{j=1}^{n} V_j'' I_j'$$

where all the e.m.f.'s have the same frequency, and shows it to be deducible directly from the network equations under the limitations of the Maxwell dynamical theory of quasi-stationary systems or networks.

The author then discards the special assumption of quasi-stationary systems and starts with the fundamental equations of electromagnetic theory, and demonstrates his generalised theorem subject only to the limitation that magnetic matter is excluded, *i.e.* it is assumed that all conducting and dielectric media have unit permeability. This limitation is required by the method of demonstration, but is not necessary in the case of a quasi-stationary system. The generalised theorem: Let a distribution of impressed periodic electric intensity $\mathbf{F}' \equiv \mathbf{F}'(x, y, z)$ produce a corresponding distribution of current intensity $\mathbf{u}' = \mathbf{u}'(x, y, z)$, and let a second distribution of equi-periodic impressed electric intensity $\mathbf{F}'' = \mathbf{F}''(x, y, z)$ produce a second distribution of current intensity $\mathbf{u}'' = \mathbf{u}''(x, y, z)$, then $\int(\mathbf{F}' \cdot \mathbf{u}'')dv = \int(\mathbf{F}''\mathbf{u}')dv$, the volume integration being extended over all conducting and dielectric media. $\mathbf{F}$ and $\mathbf{u}$ are vectors and $(\mathbf{F} \cdot \mathbf{u})$ denotes their scalar product.

As an example of the practical value of the generalised theorem it is mentioned that it enables the transmitting properties of an antenna system to be deduced from its receiving properties. The latter may often be deduced quite simply, *e.g.* the wave antenna, whereas a direct theoretical determination of the former presents formidable difficulties. G. W. DE T.

3018. *Electron Theory of Aberration and Lorentz Transformations.* **D. N. Mallik.** (Phil. Mag. 48. pp. 405–412, Sept., 1924.)—The author points out that in the usual development of the electron theory of aberration, as given by Poincaré and others, while it enables us to deduce Fresnel's drag coefficient, it supplies no clue to the Lorentz transformations as a necessary consequence of that theory. Whatever view be taken regarding the physical existence of an ether, it must be admitted, in the present state of science at any rate, that a moving electron produces a magnetic field. If this be granted, it will be justifiable to regard the total energy in the Lagrangian sense as made up of that of the electrons themselves and that of the field. The author adopted this procedure in a paper "On the Theory of Dispersion" [see Abstract 680 (1915)], and, as is shown by a general dynamical discussion in the present paper, it leads to the Lorentz transformations as the necessary outcome of the electron theory. The author makes the observation that, while this method of deriving the transformations may appear to be less elegant than some others, it seems to have the advantage of showing, so far as it goes, the implied dynamical mechanism. Moreover, while the relativistic method is mainly kinematical, here we seem to arrive at the actual source of the light signals. In the former paper it was shown that certain terms might be physically interpreted as representing rotation, thus according well with various elastic solid theories of dispersion. Such a view should fit in with Bohr's theory of atomic structure. G. W. DE T.

3019. *Electrodynamic and Electromagnetic Induction in Moving Continuous Media.* **L. Roy.** (Comptes Rendus, 178. pp. 2065–2071, June 16, 1924.)—A further mathematical development of the theorems elaborated in previous papers [see Abstracts 2122 (1922) and 2577 (1924)]. A. B. C. L.

3020. *The Speed of Propagation of Electricity.* **C. Gutton.** (Annales des Postes, Télé. 13. pp. 949–966, Sept. 1924.)—This paper deals mainly with the interval of time which elapses between the emission of a telegraphic signal and its reception at the extremity of a long line, and gives a detailed *résumé* of the investigations made since Fizeau's pioneering work in 1850. The current diffusion discovered by Fizeau and Gounelle is discussed at length. Kirchhoff's researches on the propagation of electricity along wires, and his result of a propagation speed equal to that of light, next receive attention. The result only obtains for wires of low resistance. Following this comes a brief review of the work of Heaviside and Vaschy, whose equations were integrated by Poincaré using Bessel functions, and led to Kirchhoff's results. Poincaré's investigation is then discussed. The contributions of Maxwell, Hertz and Blondlot are then described, after which are detailed some experiments by the author himself for the direct comparison of the speeds of light and of electric waves of 1·35 m. wave-length along copper and more resistant wires, using a device based on the electro-optical effect of Kerr. Finally, Mercier's work, based on the synchronisation of valve oscillators, is reviewed. The paper is descriptive throughout, and should be consulted in its entirety. **H. H. Ho.**

3021. *Some Problems of Two-Dimensional Electrostatics.* **D. M. Wrinch.** (Phil. Mag. 48. pp. 692–703, Oct., 1924.)

3022. *The Derivation of Coulomb's Law from Maxwell's Tensions.* **G. Siemens.** (Zeits. f. Physik, 27. 2. pp. 118–123, 1924.)—Shows that it is possible to start with Maxwell's tension along the lines of force and pressure at right angles, and deduce the truth of Coulomb's law for the attraction of two charged particles. In the case considered charges of opposite sign $+q_1 > -q_2$ stand at a distance r in a homogeneous dielectric with constant ϵ_k. It is assumed that the lines of force which do not pass from q_1 to q_2 end on a sphere of large radius surrounding the points in a uniformly distributed charge $-(q_1 - q_2)$. One of the equipotential surfaces round q_2 is a sphere. The Maxwell pressure forces over this surface are shown to be in equilibrium, and the resultant of the tension forces outward from the surface is shown to be $\mathrm{P} = (1/4\pi\epsilon_k)(q_1 q_2/r_2)$. The same will be true for any other equipotential surface, and the force P is identical with that with which q_1 and q_2 attract one another, which is thus shown to be propagated through the dielectric. **H. N. A.**

3023. *A Contribution to the Theory of the Condenser Apparatus for the Production of the High Potentials for Röntgen Requirements.* **M. Jona.** (Zeits. techn. Physik, 5. 9. pp. 405–412, 1924.)—The installations of Hull and Greinacher are first briefly described, following which comes a detailed discussion of certain modifications and improvements employed by the author. This includes a method which permits the fall of potential occurring in condenser apparatus to be explained and calculated. The paper contains copious data illustrated by eight graphs and diagrams. **H. H. Ho.**

3024. *Note on the Capacities of Small Air Condensers.* **L. Hartshorn.** (Journ. Sci. Instruments, 1. pp. 305–309, July, 1924.)—The author considers the general case of two conductors in a dielectric medium and applies Maxwell's equations for the potentials and charges. It is shown that several definitions of capacity are possible, and for any given condenser the values of capacity obtained in each case differ, but these differences will only be of practical importance in the case of small condensers of 0·001 mf.

and less. If we define the capacity of a condenser as "the quantity of negative charge induced on either plate of the condenser when this plate is earth connected and the other plate is raised to unit potential," the value so obtained will be independent of the position of the condenser. The case of a condenser carrying alternating current is next considered, and it is shown that in general the effective capacity depends upon the potential distribution and earth effects. The desirability of making the effective capacity depend on the geometry of the system and the nature of the dielectric only is pointed out, and the conditions necessary for this are deduced. Examples of the practical realisation of the conditions are given. The importance of these considerations in the case of shielded air condensers is indicated. W. C. S. P.

√ **3025.** *A Method of Measuring very Small Capacities.* **L. Hartshorn.** (Phys. Soc., Proc. 36. pp. 399–403; Disc., 403–404, Aug., 1924.)—A bridge arrangement is described suitable for the measurement of very small capacities (of the order of 1 micro-microfarad and less) at telephonic frequencies. Means of securing (1) great sensitivity, (2) fineness of adjustment, and (3) elimination of capacities to earth and capacities due to the presence of connecting leads, are indicated, so that it is possible to measure the true intercapacity between any two conductors, *e.g.* the electrodes of a thermionic valve. As a test of the method, it is used to measure the capacity between two steel balls of 1 cm. radius and at distances apart of 2·25 to 8 cm. AUTHOR.

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3026. *Rectification with Electrostatic Relay: Contact Detectors.* **W. Kramer.** (Zeits. f. Physik, 27. 1. pp. 74–82, 1924.)—Various theories have been advanced to explain the action of contact detectors, none of which have up to the present met with general acceptance. One theory supposed that in contact detectors the electrons can only pass freely in one direction at the point of contact, and explains the action as being due to the withdrawal of electrons from the metal under the influence of powerful electric fields [Abstract 1442 (1923)]. The author has carried out experiments with the so-called electrostatic relay of Johnsen and Rahbek, using various combinations of materials, and has found that with this arrangement rectification effects can be obtained. To obtain such effects it is necessary that one of the electrodes should be an electronic conductor and the other an ionic conductor, and there must also be an electric field between the two. Characteristic curves are given for several pairs of substances, and these show a very much greater current in one direction than in the other. For example, using agate and iron, the current in the direction agate-iron for a p.d. of 8 volts is about fifteen times that in the opposite direction for the same voltage. With silver and agate the current at 200 volts in the direction agate-silver is about twenty-one times that in the opposite direction. The results obtained confirm the theory outlined above, and tend to show that this theory also holds for the contact detectors ordinarily used in wireless telegraphy and telephony. A. W.

3027. *Terrestrial Electric Field.* **C. Maurain, E. Salles** and **G. Gibault.** (Comptes Rendus, 178. pp. 2112–2114, June 16, 1924.)—At the observatory of Val-Joyeux, Villepreux, an apparatus giving a continuous record of the earth's electric field has been installed. This is the first of its kind, and is briefly described. The results of the first year's working are given in the form of curves and tables. The observations do not cover a sufficiently long period for any general conclusions to be reached. W. A. R.

3028. *Atmospheric Electric Currents, Normal and Abnormal, and their Relation to the Growth of Plants.* **V. H. Blackman.** (Roy. Meteorolog. Soc., J. 50. pp. 197–207, July, 1924.)—A lecture delivered before the Royal Meteorological Society giving a brief history of the subject and a summary of its present state. There is a probability that the normal air-earth current has a slight beneficial effect on the growth of plants, but the evidence is not yet conclusive. There is, however, no doubt now that larger artificial electrical discharges can be made to produce favourable effects. M. A. G.

3029. *Relations between Atmospherics and Meteorological Phenomena.* **R. Bureau.** (Onde Élec. 3. pp. 385–401, Aug., 1924.)—A lengthy paper, in which the subject of "atmospherics" is considered primarily from the point of view of meteorology and not from that of their intensity causing interruption of telegraphic communication. The work of Popoff and others in this region of science predates the later study from the telegraphic aspects. The author treats of the effect of currents of cool air from the polar regions meeting hot air currents from the equatorial regions, which do not mix, but slide between each other, and so cause discontinuities of humidity and temperature, to which clouds and rain effects are due, and energy transformations, such as cyclones, etc., result. The existence of such discontinuities in the atmosphere has been shown by Norwegian meteorological work. After dismissing the effects of mountain chains upon these air currents, the author gives details of "atmospheric" measurements carried out by an extensive system of French stations at different altitudes. Particular instances are given of the relations during the passage over the Alps of a clear atmospheric spot surrounded by clouds and related to low temperature and also to a case where a mass of cold air arrived at the Alps. The connected meteorological measurements and "atmospheric" measurements are discussed, and prove the author's view that atmospherics in the temperate regions are due to masses of air moving from the polar regions and forming discontinuities with air masses from the equatorial regions. In winter, when these movements are slow, the intensity of "atmospherics" is small, but is greatly increased when the effects of mountains give rise to added relative movements. [See Abstract 1135 B (1924).] B. J. L.

3030. *Meteorological Conditions and Atmospherics.* **R. Bureau** and **A. Viaut.** (Comptes Rendus, 179. pp. 394–397, Aug. 18, 1924.)—In previous papers [Abstract 1135 B (1924)] the author has pointed out that in winter atmospherics are connected with the arrival of masses of cold air. The observations made during the summer have confirmed the winter results, and hence it appears that in our latitudes and at all seasons of the year (1) atmospherics are invariably connected with the arrival of masses of polar air, even when this does not cause cloud formation; (2) they are reduced by the arrival of hot air; (3) they are strengthened when the cold air rises in mountainous regions; (4) they are also strengthened when the cold air invades regions of relatively high solar temperature;

(5) the two latter actions may combine to cause the persistence of atmospherics over long periods. A. W.

DISCHARGE AND OSCILLATIONS.

3031. *Electric Discharge in Gases at Low Pressures.* **J. J. Thomson.** (Phil. Mag. 48. pp. 1–33, July, 1924.)—Glasson's experiments [see Abstracts 60 (1912) and 948 (1914)] have shown that the direct ionisation due to the collision of high-speed kathode-rays is small at the low pressures considered. But the rays cause the molecules through which they pass to emit a radiation which ionises the gas in the neagtive glow and the dark space. The luminosity of the glow is due to the recombination of electrons and positive ions, which give rise to radiation capable of ionising gases of ionising potential less than that of the neutral atom or molecule formed by the combination of the electron and positive ion. The author, for reasons given, does not think that the kind of ionisation resulting in the detachment of a free electron is often produced by the collisions of positive ions in the dark space. The author confirms Aston's expression for the distribution of potential in the dark space, although his experiments were made at comparatively high pressures and with small p.d.s. An expression is also obtained by the author for the relation between the thickness of the dark space and the pressure of the gas.

The conditions in the negative glow seem to be those of thermodynamic equilibrium, *i.e.* if the gas filling the tube be a compound containing, say, O, H and C atoms in certain proportions; then in the negative glow there will be all possible compounds of these elements, and these compounds will be in the proportions corresponding to thermodynamic equilibrium at a suitable temperature. Stable equilibrium other than thermodynamic—*e.g.* mixtures of H and O in the proportion two volumes of H to one of O—will exist at room temperatures without chemical combination in the absence of catalysts to lend the energy to split the oxygen molecules into atoms. In the negative glow, however, energy is stored in various types of radiation and in moving electrons, all of which will act as catalysts and maintain the negative glow in thermodynamic equilibrium. Numerous experiments by the author confirm this.

Experiments on the character of the ions in the positive column are described, and an expression is obtained for the electric force in a uniform column free from striæ. G. W. de T.

3032. *The Doppler Effect in the Canal Rays of Hydrogen, Oxygen and Nitrogen.* **H. Krefft.** (Ann. d. Physik, 75. 1. pp. 75–107, Aug., 1924.)—W. Wien has shown that the neutral hydrogen atom is the carrier of the Balmer lines. These lines possess an intensive Doppler effect. The experiments of E. Rüchardt [see Abstract 2474 (1923)] have shown that the velocity distribution of the neutral and positive hydrogen atoms is not equal. In the present paper, after a description of the apparatus, the following points are dealt with in connection with the Doppler effect: Hydrogen in hydrogen; hydrogen in oxygen and nitrogen; comparison with other observations; comparison of the Doppler curve with the particle-number curve of electromagnetic analysis; the velocity distribution of the canal rays; the addition of oxygen and nitrogen in the discharge space; the Doppler effect in the pencil; the Doppler effect in the spark lines of oxygen and nitrogen. The results are shown in both tabular and graphical form. A. E. G.

3033. *Report on the Doppler Effect in Arc and Spark Lines.* **H. Krefft.** (Phys. Zeits. 25. pp. 352–366, July 15, 1924.)—The paper consists of a discussion of the results obtained with respect to the Doppler effect in lines of the spectra of hydrogen, oxygen and nitrogen, with particular reference to the variations of the magnitude of the effect with the charge on the source of radiation. The effects of variation of accelerating potentials, distribution of velocities among the particles, are mentioned, differences in the effects observed in arc and spark lines being explained in terms of measurements on homogeneous canal rays. Hence a standpoint for the investigation of the origin of spectral lines from the Doppler effect is obtained. W. V. M.

3034. *Researches on the Carbon Arc—Vapour Pressure Determinations of the Carbon.* **H. Kohn** and **M. Guckel.** (Zeits. f. Physik, 27. 5–6. pp. 305–357, 1924.)—Fajans has investigated [see Abstract 173 (1921)] the heat of sublimation and valency-forces of carbon modifications. It is found in the present experiments that the surface brightness, and with it the temperature of the positive craters of pure carbon above a "normal loading," reaches a maximum value and retains it with further increase in the loading. At atmospheric pressure this constance is observed in the loading range 0·3 to 2·1 amp./mm.^{2}. Different varieties of pure carbon reach the same "highest" temperature. The "highest" temperature has the same value in free air, in an enclosed air-filled vessel, in 98 % CO_2, in almost oxygen-free nitrogen, and in 99·5 % argon. The ionisation ratios in the arc, from the characteristics ascertained, are, in part, very different in the gases examined, in spite of the use of pure carbon. The greatest difference, in amount about 50 %, in the anode fall occurs between air and argon. The negative carbon can also reach the "highest" temperature of the positive crater, but no higher. The results show that the equilibrium temperature of the crater is independent of the chemical and electrical activities in the arc. The setting up of an equilibrium temperature in the crater is proved in the following cases in the pressure intervals named: (1) CO_2, between 0·06 and 5·0 atm.; (2) Air, between 0·06 and 3·2 atm.; (3) N_2 and Ar, between 0·06 and 2·0 atm. The "normal loading" increases with diminishing pressures. A. E. G.

3035. *Calculation of the Potential Drop in the Ionic Stream from Glowing Metals.* **M. v. Laue** and **N. Sen.** (Ann. d. Physik, 75. 2. pp. 182–188, Aug., 1924.)—The equilibrium between a mixture of electrons, ions, and a glowing conductor has already been examined experimentally and thermodynamically [Abstract 1260 (1924)]. In the same way the potential drop is now evaluated and the numbers calculated for K, Na, Pb, and Al. A. C. M.

3036. *Application of the Law of Probability to the Spark.* **G. Polvani.** (N. Cimento, 1. pp. 217–225, July–Aug.–Sept., 1924.)—If sparks are allowed to take place between a point and an indefinite plane, the probability that they hit a certain point can be calculated by Gauss' law. In particular, the probability that the spark hits a point comprised in a circle of radius r, the centre of which is the projection of the point upon the plane, is given by the expression $1 - \epsilon^{-K^2r^2}$, where K is a constant depending upon the conditions of the experiment.

The experiments for verifying this law were made by using a bronze disc covered with black thin paper. The paper with the small holes due to the sparks was used to obtain a photograph. By counting the number of holes within circles of different radii, K was really found constant, as long as r was not too large, to which fact should be attributed the difficulty for the spark to jump too large spaces. In particular, the product $K\Delta$, where Δ is the distance of the point to the plate, was found to be constant. E. B.

3037. *Wall-Currents; Theory of Positive Columns.* **W. Schottky.** (Phys. Zeits. 25. pp. 342–348, July 15, 1924.)—The problem is the loss of charge by diffusion of the carriers to the walls. Electrons rapidly effect discharge and have little time for recombination, but they must have a strong tendency to diffusion. The positive ions are heavy compared with the electrons; they diffuse slowly, but are attracted by the walls, which have already been reached by the more rapidly moving electrons, and there they recombine with the electrons. Ions of both signs therefore travel towards the walls in an ambipolar discharge, but the ions of opposite signs have different velocities or "temperatures." Away from the walls and electrodes the number of positive and negative charges is practically the same. Given an axial concentration the ambipolar diffusion-stream can be computed. It can, however, hardly be measured without negatively charging the walls so as to keep back the electrons and allow the positive ions only to pass, thereby making the discharge unipolar, with a saturation value; then the number of electrons may be reckoned as equal to that of the positive ions, or very nearly so. The number of particles ionised is proportional to the axial potential-gradient $= k(\partial v/\partial z)$. The concentration of + and − ions is greatest at the axis; so is the production of new ions. The concentration falls off from the axis in the same way as a Bessel function J_0 falls off from 1 at $x = 0$ to 0 at $x = 2{\cdot}405$. An expression is reached for the potential gradient, parallel to the axis of the tube, of the positive columns, *viz.*:—

$$\frac{\partial V}{\partial z} = 2{\cdot}405\sqrt{\frac{V_i}{k}}\sqrt{\frac{k_+}{k_-}}\sqrt{B_+ + B_-}\,\frac{1}{r}$$

where V_i is the ionising potential in volts, B_+ and B_- are in volts the potential equivalents of the "temperatures" of the + and − ions, and r is the radius of the tube. This is independent of the current and inversely proportional to the radius of the tube (Cf. Claude, Comptes Rendus, 158. pp. 692–697, 1914). Discussion of particular cases.—The lateral potential gradient in positive columns also considered.—Experimental methods. A. D.

3038. *The Electrodeless Ring Discharge.* **H. Jung.** (Ann. d. Physik, 95. 2. pp. 201–210, Aug., 1924.)—In order to set up the ring discharge free ions or electrons are necessary, and these are obtained by radium radiations. These are accelerated in an alternating electric field, and so attain on their free path length sufficient energy to set up either ionisation or many-fold ionisation of the struck atoms. Which of these degrees of excitation is favoured is dependent only on the length of the free path and therefore on the pressure of the vapour or gas in the discharge vessel. An apparently previously uninvestigated band spectrum of Hg is found which, in opposition to the known band spectra of Hg, seems to actually belong to a Hg_2-molecule [see also Abstracts 192 (1918) and 1689 (1922)]. A. E. G.

3039. *The Disappearance of Gas in the Electric Discharge* (*V*). **Research Staff of the General Electric Co., London.** (Phil. Mag. 48. pp. 553–580, Sept., 1924.)—The purpose of these experiments is to discover a relation between the rate of absorption of a gas in the electric discharge and the rate of ionisation of its molecules. It is pointed out that the true electrical absorption, dependent simply on ionisation or allied processes, is entangled with other causes of absorption and evolution of gas; the main difficulty is to disentangle it. The experiments show that in nitrogen and carbon monoxide the rate of absorption is proportional to the rate of ionisation and approximately, at least, independent of the pressure, the speed of the ionising electrons, and the arrangement of the electrodes. It depends very greatly on the condition, but not very greatly on the material, of the walls of the vessel. The number of molecules disappearing is often greater than the number ionised. In argon there is no evidence of an absorption simply related to ionisation. In hydrogen the facts are obscure, but it is probable that there is an electrical absorption more rapid than in N_2 or CO. An attempt is made to explain the facts. In spite of the simple relation between absorption and ionisation, it does not seem possible to hold that the ions are absorbed. Alternative theories are discussed: (1) That monatomic molecules are liberated by ionisation, (2) that partially ionised or excited molecules are absorbed, but both are open to grave objection. The molecules almost certainly are absorbed by reaction with the walls of the vessel, but no suggestion can be made as to the nature of the reaction. Some observations, to be completed in a later paper, are described on the evolution of gas from glass vessels when heated, after they have been submitted to the usual processes of baking during exhaustion. It appears that there is no definite amount of gas that can be evolved by such heating, but rather that an equilibrium pressure is established [see also Abstract 1891 (1924)]. A. E. G.

3040. *The Thermic Equilibrium of Ionisation.* **E. Fermi.** (N. Cimento, 1. pp. 153–158, May–June, 1924.)—Saha has proposed a theory of ionisation of gases as a temperature effect in which the transformation of a neutral atom into a positive ion and an electron is considered as an ordinary chemical reaction of dissociation. As a result of the discussion put forward in the present paper it is concluded that the correction brought to the formula of Saha, by taking count of the equilibrium of all levels of energy of the atom, is, generally speaking, very small. The greater differences occur with the alkaline metals and for the higher temperatures. A. E. G.

3041. *Thermionic Emission from Systems with Multiple Thresholds.* **O. W. Richardson.** (Phys. Soc., Proc. 36. pp. 383–398; Disc., 398, Aug., 1924.)—In the introductory part of this paper reasons are given why it is necessary at the present time to face the question of the connection between thermionic emission and the internal electron levels of the emitting substance. The theoretical problem is attacked from three different points of view, namely, (*a*) classical statistical mechanics, (*b*) chemical dynamics, and (*c*) the laws of photoelectric action. As a result of this discussion it seems possible to exclude certain alternatives which might otherwise have appeared not improbable and to formulate a set of rules governing the fundamental phenomena which are not in conflict either with the known facts or with any well-recognised relevant principle. AUTHOR.

3042. *Variation of Temperature and of Electronic Emission from a Tungsten Filament made Incandescent by Alternating Current.* **M. Paris.** (Elettrotecnica, 11. pp. 673–677, Sept. 25, 1924.)—This paper is divided into two main sections: (1) Measurements with continuous currents, (2) measurements with alternating currents. Diagrams of the circuits employed in each case are given, and the results obtained are shown in a series of graphs. A. E. G.

3043. *Active Modification of Nitrogen.* **M. N. Saha and N. K. Sur.** (Phil. Mag. 48. pp. 421–428, Sept., 1924).—It is sought to show that almost all of the observations recorded by Rayleigh on the afterglow and chemical and spectral activities produced in nitrogen gas by the action of a condensed spark discharge can be explained on the basis of Klein and Rosseland's theory of inelastic collision of the second type. A. B. C. L.

3044. *Some Cases of Polymorphic Transformation Energies.* **A. Hare.** (Phil. Mag. 48. pp. 412–421, Sept., 1924.)—Experimental work is described having for its object the determination of the transformation energies of substances showing luminescent properties when bombarded with kathode-rays. An exceptional non-immediately reversible transformation is noted in the case of sodium molybdate, the conditions of recovery of which are specially studied. A. B. C. L.

3045. *Harmonic and Multiple Synchronisation.* **J. Mercier.** (J. de Physique et le Radium, 5. pp. 168–179, June, 1924.)—The subject is divided into two sections: I. The application to a new method of determining the period of electrical oscillations of high and of very high frequency; II. Application to the determination of the velocity of propagation of electromagnetic waves along wire conductors. The precision of the measurements described shows that the phenomena of stationary waves along two parallel wires, which until now have appeared very simple, is, in reality, extremely complex, and that there are numerous difficulties in the study of short waves. The influence of lack of symmetry in the experimental arrangements is shown. The perturbations in the distribution of stationary waves along the wires and perturbations resulting from the presence of exterior objects is also considered. The determination of the velocity of propagation of electromagnetic waves along the wires has been carried out with an accuracy of 1/10,000, *i.e.* within an error of less than 30 km. per sec. The influence upon this velocity of the diameter and distance of the wires has been established. A theoretical calculation is made of this same velocity starting from constants of the wires, which give results quite in accord with experimental results. It is by these means found that the velocity in air is 299,700 km. per sec. The method here described is contrasted with the English method, and it is claimed that the advantages lie with the former [see also Abstract 1374 (1922)]. A. E. G.

3046. *Electron Emission excited by α-Rays.* **A. Becker.** (Ann. d. Physik, 75. 3. pp. 217–275, Sept., 1924.)—In an earlier work the author [see Abstract 135 (1920)] has made a comparison between the photoelectric and thermal emission of ions; an exact parallelism was also then established between photoelectric and thermal electron emission. In the present paper the electron emission due to the action of α-rays is considered. Diagrams of the apparatus used are given, and the results obtained are shown in both graphical and tabular form. In very high vacua the quantity of electrons set free by α-rays from the metals aluminium, silver and gold show to a first approximation no dependence on the nature of the metal and on the direction of the rays. The quantity of electrons emitted depends on the velocity of the α-rays in the same manner as with gases. It amounts to about 10 per α-particle for a velocity of the latter of $1 \cdot 5 \times 10^9$ cm./sec. The absolute value of the velocity of the electrons is independent not only of the nature of the metals and the emission direction, but also of the velocity of the exciting α-rays. The most probable value lies in the neighbourhood of 2 volts. Whether the number of electrons with greater velocities fall asymptotically to nil, or whether there is a certain limiting value of the velocity, cannot be stated with certainty. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

3047. *Relation between Tensile Strength and Electrical Resistivity of Commercially Pure Copper.* **W. E. Alkins.** (Inst. of Metals, J. 31. 1. pp. 157–161; Corres., 162–163, 1924.)—The relationship between the electrical resistivity and tensile strength of copper wire, when the latter is raised by drawing, is studied, and it is found that for tensile strengths above 20 tons per sq. inch the relationship is practically a linear one.

J. L. H.

3048. *The Photoelectric Effect and Temperature.* **M. Curie.** (Comptes Rendus, 179. pp. 105–108, July 16, 1924.)—Particulars are given of the variation in magnitude of the photoelectric effect exhibited at temperatures ranging from 0° to 400° C. by various substances—calcium sulphide, fluorspar, zinc sulphide and cadmium sulphide—containing phosphorogenic impurities. [See also Abstract 2491 (1924).]

J. S. G. T.

3049. *The Variation in the Resistance of Carbon and Graphite with Temperature.* **B. Noyes, Jr.** (Phys. Rev. 24. pp. 190–199, Aug., 1924.)—Measurements have been made up to 2000° C. and down to − 190° C. At high temperatures the specimen was heated by passing a current through it *in vacuo*, the temperature being measured optically. Untreated carbon filaments made from braided silk decreased linearly with temperature; the ratio to the resistance at room temperature was $1 \cdot 07 - 0 \cdot 000225T$, where T is the absolute temperature. A metallised filament and Acheson graphite showed a minimum resistance (at 400° C. and 600° C. respectively). **H. N. A.**

3050. *Dielectric Constants.* **P. Walden** and **O. Werner.** (Zeits. phys. Chem. 111. pp. 465-471, Aug. 25, 1924.)—By a resonance method, using waves of 4½ m. length, the dielectric constants of chlorinated paraffins and olefines have been measured. There was a considerable difference between the constants of the two stereoisomer of dichlorethylene. There is a parallelism with the tendency to ionisation (coloured ions) and a proportionality between the solubilities and the dielectric constants. **A. D.**

3051. *The Conductance of Solid Salts at Elevated Temperatures.* **P. Vaillant.** (Comptes Rendus, 179. pp. 530–532, Sept. 15, 1924.)—The author continues his previous observations [Abstract 631 (1924)], and finds analogous maxima and minima in conductance using such salts as NaCl, KSO, KCl, verifying his observation of two types of conduction. **W. V. M.**

3052. *Electrical Conductivities of Mixtures of Aniline, Acetic Acid and Water.* **J. R. Pound.** (Chem. Soc., J. 125. pp. 1560–1564, Aug., 1924.)—The electrical conductivity of mixtures obtained by adding aniline to aqueous solutions of acetic acid of various strengths shows that the best conducting mixtures are obtained by adding small amounts of aniline to solutions of low acid content. These correspond in general to mixtures of greatest contraction and viscosity (see Chem. Soc., J. 125. p. 769, 1924). As a result of these investigations it is concluded that ternary mixtures in which complex formation is developed are mixtures of good conductivity, the more aqueous mixtures being the better conductors. **B. W. C.**

3053. *On the Relation between Metal Contact Potentials and the Peltier Effect.* **J. A. V. Butler.** (Phil. Mag. 48. pp. 746–752, Oct., 1924.)—In this paper the statistical theory of metal boundary potentials is developed and an equation giving the relation between the thermionic work functions of metals and the corresponding contact p.d.'s is obtained. The Peltier heat effect at the junction of two metals is accounted for, and the various equations of the thermoelectric effect in a circuit of two metals with junctions at different temperatures are completely coordinated. On certain assumptions these equations lead to the conclusion that the Thomson p.d. is the same for the same difference of temperature in all conductors. **H. H. Ho.**

3054. *Some Electro-Mechanic Applications of Arc Relays with Exterior Sheath.* **L. Dunoyer** and **P. Toulon.** (Comptes Rendus, 179. pp. 386–389, Aug. 18, 1924.)—An extension of the work is described in a previous paper [see Abstract 2837 (1924)] and in the next abstract. **A. E. G.**

3055. *Some Electro-Optical Applications of the Arc Relay.* **L. Dunoyer** and **P. Toulon.** (Comptes Rendus, 179. pp. 461–464, Sept. 1, 1924.)—In a previous paper [see Abstract 2837 (1924)] the authors have described a remarkable property of the positive column of the mercury arc and the influence of exterior sheaths. In the present paper the results there described are extended to the following applications: (*a*) Optical signalling; (*b*) optically directed radiophony; (*c*) registration and reproduction of speech; (*d*) telephotograph and television; (*e*) optical reception of radio-electric signals. A. E. G.

3056. *Measurement of Very Small Alternating Potential Differences with an Electrometer.* **C. Gutton and G. Laville.** (Comptes Rendus, 179. pp. 392–394, Aug. 18, 1924.)—The needle of the electrometer is a rectangular strip of aluminium paper, the ends of which are bent at right angles in opposite directions. It is suspended by a quartz filament about 3 microns in diameter, and carries a small mirror. In the equilibrium position the bent back ends of the needle are inclined to the fixed plates; and when there is a difference of potential between the latter the needle turns, so that its end planes tend to become parallel to the fixed plates. The instrument has a very stable zero, but very large damping; it is calibrated at 50 alternations, and is used at 896. The measurement of the apparent resistance and inductance of a Brunet telephone receiver, with 1890 ohmic resistance, is described; also of a repeating coil and of the secondary of the induction coil of a telephone. H. N. A.

3057. *A Convenient Photoelectric Photometer and Densitometer.* **E. A. Baker.** (Journ. Sci. Instruments, 1. pp. 345–347, Aug., 1924.)—A short-period electrometer is described which has an exceptionally long scale and gives readings proportional to the ratio of two potentials. It is applied in the construction of a photoelectric photometer and a photoelectric densitometer, both instruments being independent of battery variations. AUTHOR.

3058. *A Revolving Mirror for Use with the String Galvanometer.* **A. Forbes** and **D. W. Mann.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 807–816, June, 1924.)—The usual method of observing results with a string galvanometer is photographic recording, but for some purposes it is highly desirable to observe the excursions of the string as they occur. In particular this need is felt in the case of many researches in nerve physiology, and the authors describe an optical scheme involving a revolving mirror whereby this may be carried out. Examples of records obtained of action currents in nerves are given. W. V. M.

3059. *The Capacities of Electron Tubes.* **E. Schrader.** (Zeits. f. Hochfrequenztechn. 24. 2. pp. 27–38, 1924.)—The subject is dealt with under the following heads: Calculation of the probable tube capacity from the tube data according to H. G. Möller; the apparatus; the measurements; the comparison of formula with experimental results; the use of the results obtained in a practical case; difficulties in the graduation of the new measuring apparatus; measurements on the high-frequency intensifiers. A. E. G.

ALTERNATING CURRENTS AND MAGNETISM.

3060. *The Field at a Great Distance produced by a High-Frequency Current in a Straight Conductor.* **J. Bethenod.** (Rev. Gén. d'Él. 16, pp. 451–452, Sept. 20, 1924.)—In a conductor AA′ of length l there are two waves, one of amplitude A, which at a given instant is moving from

A′ to A, and a second of amplitude B, moving from A to A′. ϕ is the phase difference at the central point O of the conductor between the two waves. It is shown that at a distant point on a line making the angle θ with OA the real amplitude of the field H, due to the combined action of the two waves, is :—

$$\mathrm{H} = \sqrt{\mathrm{H}'^2 + \mathrm{H}''^2 + 2\mathrm{H}'\mathrm{H}''\cos\phi}$$

$$\text{where}\quad \mathrm{H}' = \mathrm{A}\lambda\sin\theta\sin\{(1 + \cos\theta)\pi/\lambda\}/\pi(1 - \cos\theta)$$

$$\mathrm{H}'' = \mathrm{B}\lambda\sin\theta\sin\{(1 - \cos\theta)\pi/\lambda\}/\pi(1 + \cos\theta)$$

The assumption is that the field in the direction θ at a very great distance, due to an element of the conductor at O, produced by the first wave, is of the form A sin $\theta e^{j\omega t}dx$. The formulæ are employed to solve the two cases where there is a loop and where there is a node at O.

H. N. A.

3061. *Relations between the Anomalies of Terrestrial Magnetism and those of Gravity.* **P. Lasareff.** (J. de Physique et le Radium, 5. pp. 191–192, June, 1924.)—This is a mathematical paper based on the assumption that the bed which is the cause of the anomalies of magnetism and gravity has the form of an infinite prism, having for section a parallelogram of which one side is infinitely small in comparison with the other. [See also Abstract 1300 (1924).]

A. E. G.

3062. *Gravity Anomaly, Koursk, Central Russia.* **P. Lasareff.** (Comptes Rendus, 178. pp. 2186–2187, June 23, 1924.)—A gravity anomaly found at Koursk has been shown to be due to a buried mass of magnetite which has been explored [Abstract 2163 (1924)]. Calculations now made show that this mass is competent to account for the anomaly in question.

W. A. R.

3063. *Magnetism during Solar Eclipse,* 1923. **J. P. Ault.** (Terrest. Magn. 29. p. 72, June, 1924.)—A brief account of the examination of the magnetic data obtained during the solar eclipse of September, 1923, confirms previous indications that the disturbance effects are appreciably modified by altitude. The effect on the horizontal and vertical intensities at the five observatories, if present, was quite small. [See Abstracts 2162 and 2696 (1924).]

W. A. R.

3064. *On the Accumulation of Data on Local Magnetic Disturbances and on the Methodology of their Reduction.* **B. Weinberg.** (Terrest. Magn. 29. pp. 80–84, June, 1924.)—Outlines a method of studying "local magnetic disturbances," at the same time endeavouring to give precision to the meaning of the term, and also appeals for cooperation.

M. A. G.

3065. *Twenty-seven-Day period (Interval) in Terrestrial Magnetic Disturbance.* **A. L. Cortie.** (Roy. Soc., Proc. 106. pp. 19–32, July 1, 1924.)—The author claims to show by this research that the existence of a 27-day period or interval in a series of magnetic disturbances is connected with a *restricted area* of solar disturbance and not with a periodic disturbed condition of the whole solar surface—a question raised by Chree [see Abstract 89 (1923)]. The treatment is not a statistical one, but consists of an examination of individual terrestrial magnetic and solar conditions during the years 1921, 1922 and part of 1923, this period being chosen as being a time of low sunspot frequency and low sunspot latitude, and therefore conducive to the development of the 27-day interval (see Chree, *loc cit.*). It was found to be marked by two long series of magnetic disturbances, each at intervals of 27 days, one from May 12, 1921, to April 13, 1923, and the other from Oct. 27, 1921, to July 11, 1923, while sunspots were confined to two well-marked patches of recurrent disturbance. These are discussed in detail and related, the one magnetic series to one patch of disturbance and the other to the other, the main support being found in agreement between the position on the sun of the disturbed areas and coordinates derived from the magnetic series, a mean solar latitude from the magnetic sequence intervals and a mean solar longitude from the longitudes of the sun's central meridian on the days of magnetic disturbances.

Other results given comprise that in each magnetic series the most active disturbance synchronised with solar calm, and that magnetic disturbances with 27-day interval persist even when the sunspots have disappeared. The flocculi and faculæ which remain when the accompanying sunspots have disappeared are an evidence of the maintenance of the activity of the region. M. A. G.

3066. *Position of the Lines of No Secular Variation of Magnetic Declination in Siberia for Different Epochs.* **B. Weinberg.** (Terrest. Magn. 29. pp. 73–79, June, 1924.)—R. Abels has called attention to the westward movement of the line of no secular variation of magnetic declination in Siberia during the period 1900–1919 [see Abstract 380 (1923)]. The present paper confirms this result, using supplementary data, and then deals with conditions during an earlier period. It appears that there was also a westward movement during the nineteenth century, but at a much slower rate (about 0·2° a year), and that the more rapid movement did not commence until the beginning of the twentieth century. M. A. G.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

3067. *The Protection of the Radiologist.* **P. Angebaud.** (Arch. d'Él. Médicale, 32. pp. 270–272, Sept., 1924.)—The dangers of stray radiation are discussed in a general manner. Means of cutting off this undesired radiation at the source (*i.e.* tube) are described, and the limitation is due to constructional difficulties with the thicknesses of protective material required. The author then describes a protective material in which barium salts are glued between veneer—or, better, muslin—which allows a greater equivalent protection to be obtained for a given thickness. As an adhesive material the silicates of sodium or potassium can also be used. These, when dried, give a very hard protective material which can be produced in the form of bricks. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

3068. *Gas-Liquid Bounding Surfaces.* **A. Frumkin.** (Zeits. phys. Chem. 111. pp. 190–210, Aug. 5, 1924.)—The adsorption of capillar-active substances on an air-water bounding surface is associated with the production of a definite p.d. at the surface. The results can be explained if we admit with Langmuir and Harkins that the adsorbed molecules are orientated by the surface forces and also that the combinations CO, CCl, CN have a definite polarity (C positive; O, Cl and N negative) and that the combination CC has no polarity. A. D.

3069. *The Electrical Nature of Adsorption Forces.* **W. Tarassoff.** (Phys. Zeits. 25. pp. 369–374, Aug. 1, 1924.)—Adsorption is regarded as due to the operation of electrostatic forces, and the expression $Q = A\left(1 - \frac{1}{\epsilon}\right)$ is derived for the magnitude of the heat effect Q, ϵ being the dielectric constant of the adsorbed gas. A is an expression involving the electrostatic effect. From this, by using the Lorentz-Lorenz relationship, the expression $\frac{Q'}{Q''} = \frac{\epsilon_0' - 1}{\epsilon_0'' - 1}$ is obtained, connecting the heats of adsorption of any two gases with their dielectric constants. This necessitates a linear relationship between these two properties, which is shown to exist when the figures of Homfray and Tiloff are plotted graphically. A further development of this equation shows that $Qv_0^2 =$ constant where v_0 is the ionisation potential of the gas. A slight modification of these equations is shown to apply to the adsorption of liquids by powders insoluble in the liquids. From this it is deduced that if a mixture of liquids is exposed to an adsorbing material the liquid with the greatest dielectric constant will be adsorbed first. This is illustrated by experiments with petroleum, the dielectric constant increasing with the density of the hydrocarbon, and the compound of greater density always being adsorbed, in, for example, the case of filtration. The relationship between the factors discussed above and the surface energy of solid bodies is arrived at, quantitative examples being worked out. Comparison is made with the work of B. Iliin [see Abstract 2848 (1924)]. B. W. C.

3070. *Electronic Theory of Valency. Part IV. Origin of Acidity.* **T. M. Lowry.** (Faraday Soc. Trans. 19. pp. 485–487, Nov., 1923. Phil. Mag. 47. pp. 1021–1024, May, 1924.)—Various suggestions already made [Abstract 338 (1924)] as to the nature of acids and the origin of acidity are here united to form a definite hypothesis. The definition of an acid as a hydride from which a proton can be detached—*e.g.* on dissolution in an ionising solvent, on electrolysis, or by displacement by a metallic ion—is retained, and reasons are advanced against any restriction or widening of this definition.

The increasing acidity of the hydrides from CH_4 to FH or from SiH_4 to ClH is attributed to a progressive diminution in the size of the orbits of the electrons by which the protons are linked to the central nucleus. The suggestion is made that acylous atoms such as chlorine tend to diminish the size of the orbits of electrons which they share with another atom, and that this effect can be transmitted to other orbits of the same quantum number in the latter atom. In this way the transmission of acidity through a chain of atoms can be interpreted by means of a dynamic instead of a static model. Conversely, basylous groups must expand the orbits of electrons which they share with other atoms. From this point of view an unsubstituted hydrocarbon chain should act as a neutral radicle in carboxylic acids, since orbits shared by two carbon atoms will be of normal dimensions. Hydrogen directly attached to an atom of sulphur, phosphorus, etc., is more acylous than an alkyl radicle because it allows for a greater contraction of the orbits, but even a proton is less acylous than the "lone pairs" of electrons in acids such as FH and ClH, since contraction is probably at a maximum in orbits which are entirely unshared. T. H. P.

3071. *Influence of Temperature and Concentration on the Surface Activity of Solutions.* **P. Rehbinder.** (Zeits. phys. Chem. 111. pp. 447–464, Aug. 25, 1924.)—The surface activity G of a solution is measured by the diminution in the surface tension σ corresponding to the increase in the concentration c of the solute, so that $-\delta\sigma/\delta c = G(c, T)$. The surface tension of a liquid can be measured by determining the weight of the drops, by the capillary rise and by the bursting pressure of the air bubbles formed in the liquid. In the case of solutions, as distinct from pure liquids, the author finds that the most reliable method for the determination of the maximum bubble pressure is that proposed by Zickendraht and Feustel. A glass tube (3 mm. in diameter) is drawn out to a fine capillary point, the edges of which must be left sharp; they should not be rounded off with a gas flame. The point of the tube is lowered into the liquid by means of a micrometer screw, and air from a gas-holder is forced through. The liquids investigated between 0° and 100° are aqueous solutions of five fatty acids (C_3 to C_7) and their tetra-alkylammonium chlorides. When the G are plotted against the temperatures, the curve is a straight line only for inactive or faintly active substances; otherwise the activity steadily decreases, or increases first to a maximum (between 10° and 40°) as the temperature is raised. The adsorption of gases conforms to the formulæ of both Iliin and of Eucken; for the activities the Iliin formula has to be used. The dilution law of Szyszkowsky and the law of Duclaux-Traube are confirmed. In the case of the chlorides the surface layers absorb both the ions and the undissociated substance. H. B.

3072. *The Applicability of Beer's Law to Copper Sulphate Solutions.* **R. Mecke** and **H. Ley.** (Zeits. phys. Chem. 111. pp. 385–397, Aug. 25, 1924.)—The molar extinction of light k in solutions of different concentration was determined for different wave-lengths. For wave-lengths from about 2910 Å. downwards the curves showing the relation between k and λ do not coincide for the different concentrations employed, the value of k commencing to shoot up sooner, *i.e.* for larger wave-lengths with high concentrations than for smaller ones, in all cases becoming very large for short wave-lengths. For wave-lengths between 6600 Å. and 5460 Å., on the other hand, k alters very little with the concentration; and the same is true in the infra-red, where it has a pronounced maximum value at $\lambda = 0{\cdot}813\,\mu$. Copper chloride, on the other hand, shows marked deviations from Beer's law, both in the visible part of the spectrum and the infra-red as well as in the ultra-violet. When very dilute the absorption spectrum of the chloride approaches that of the sulphate; it seems that at these high dilutions the colour is due to the ion Cu^{++}, while with greater concentrations various hydrated and auto-complex ions are formed which have a different colour. It is suggested that, in concentrated $CuSO_4$ solutions, besides cathions, such as $[Cu4H_2O]^{++}$, there are a certain number of anions containing copper, such as $[(SO_4)_2Cu]^{--}$, this being probably hydrated to $[(SO_4)_2Cu(H_2O)]^{--}$. The remarkable optical constancy in the red is explained by supposing that here the complex anions and cathions absorb equally, which is not the case with $CuCl_2$. Apparently there are also complexes in solutions of $CuSO_4$ in strong sulphuric acid, though here the relationships are not so simple. The addition of H_2SO_4 diminishes the absorption in the visible part of the spectrum, which clearly depends on dehydration. Crystallised water-free $CuSO_4$ is colourless.

Fajans has suggested that the ion Cu^{++} is colourless in itself, and that the blue colour is due to a deformation of the electronic envelope of the water of hydration, caused by the close approach of the cathion. Weigert has come to the conclusion that the quantum theory makes it possible that deviations from Beer's law may be produced when the particles come very close together. H. N. A.

3073. *Condition of Hydrogen dissolved in Platinum.* **K. Bennewitz** and **P. Günther.** (Zeits. phys. Chem. 111. pp. 257–268, Aug. 5, 1924.)—That hydrogen dissolved in platinum is dissociated into atoms was almost certainly proved by Sieverts and Jurisch (1912) by the observation that the solubility of the gas in the metal is proportional to the square root of the pressure, and Richardson's results [Abstract 1219 (1904)] indicate that the hydrogen atom is present in the platinum as positive ion separated from the negative electron.

The presence of hydrogen molecules in the metal is also excluded by consideration of the matter in accordance with Bohr's representation of atomic structure. In consequence of the strong fields between the platinum atoms, expressed in the cohesion and in the high heat of sublimation of platinum, the paths of the electron round the hydrogen nucleus must differ so greatly from the Bohr paths that the assignation of a definite nucleus to a definite electron in the sense of the Bohr model is scarcely possible.

The authors' experiments deal with measurement of the electrical resistance of the platinum charged with hydrogen. When subjected to prolonged heating, platinum itself shows a diminution in resistance, owing to recrystallisation. This change in resistance proceeds only until a certain minimum value is reached, and at higher temperatures is outstripped by the influence of the dissolved hydrogen, which causes marked increase in the resistance. T. H. P.

3074. *The Theory of Debye applied to the Dilution and Partition Coefficients of Strong Electrolytes.* **P. Gross** and **O. Halpern.** (Phys. Zeits. 25. pp. 393–397, Aug. 15, 1924.)—The chief features of the theory considered are: (1) Strong electrolytes are completely dissociated in solution; (2) the observed deviations from the classical theory for dilute solutions are caused by electrical interionic forces [see Abstract 2541 (1923)]. Strong

electrolytes are not necessarily completely dissociated in solvents other than water; experiments show that the dissociation diminishes with decreasing values of the dielectric constant, while at the same time the interionic forces will increase. The influence of the various factors is discussed mathematically and the expression is derived $K = \frac{\alpha^2 c f_a^2}{1 - \alpha}$ where α = fraction dissociated, c = concentration of solution in mols. per litre, k = Debye's dissociation constant, f_a = activity coefficient of ions, which is calculated from the valency, the dielectric constant, the ionic radius, and the absolute temperature by a method worked out by Debye. This expression is developed for the cases of complete dissociation, medium dissociation and small dissociation by the summation of convergent series, so that the true dissociation constant of a strong electrolyte can readily be calculated. It is indicated that a similar method of treatment may be applied to conductivity and osmotic pressure phenomena. In the case of partition between two solvents, for the undissociated portion of the electrolyte the relation $\frac{c_1^{m_1/m_1'}}{c_1'} = K_1$ holds, m and m_1' being molecular weights. Much of the existing experimental data cannot be used to test these conclusions, since either the electrolytes used are too weak, the concentration too great, or the solvents used are themselves miscible. A series of experiments with picric acid in water and benzene, water and chloroform and water and toluol satisfy these requirements, however, and the calculated values for the ratio K/k = dissociation constant/partition constant show only small variations from an average value in each case.
B. W. C.

3075. *The Electrolytic Theory of Corrosion.* **W. D. Bancroft.** (J. Phys. Chem. 28. pp. 785–871, Aug., 1924.)—The electrolytic theory of corrosion is formulated and its application to a number of special cases discussed. The conclusions of Bengough and Stuart [Abstract 1209 B (1923)] are criticised.
T. H. P.

3076. *The Kinetics of Gelatinisation.* **R. Reiger.** (Kolloidchem. Beihefte, 19. pp. 381–440, Sept., 1924.)—The progress of gelatinisation of gelatine solutions is measured by the change with time of the viscosity, elasticity and the rotation of the plane of polarisation. The possible determining factors of gelatinisation may be attributed, in view of its optical activity, to either electrolytic dissociation, the formation or decomposition of molecular aggregates, the presence of highly polymerised or crystal molecules in the solution, hydration, or hydrolysis. An irreversible decrease of viscosity, optical activity and gelantinising power occurs on heating gelatine solutions above 70° C., and is to be attributed to hydrolysis giving β-gelatine. It is considered that the main cause of the successive changes is the formation of molecular aggregates, which undergo a certain degree of hydration. In analogy with the change from polysaccharides to sugars a progressive breakdown of the aggregates occurs by hydrolysis, and is accompanied by a gradual disappearance of the colloidal nature of the compound.

At a temperature of 25° C. the change of activity with time is given by a graph, in which three breaks can be recognised, and consists of a series of three intersecting curves of short but varying radii, thus indicating discontinuities in the relation. This relation is made more prominent by plotting da/dt against a, where a is the activity, when three rectilinear curves of different slopes are obtained. It is concluded that gelatinisation is determined by a series of molecular changes, which proceed in separate steps, as $G_0 \rightleftarrows$, $G_1 \rightleftarrows$, $G_2 \rightleftarrows$ . . . G_n. Each stage proceeds as an exponential or monomolecular reaction. The problem is next attacked by determinations of viscosity and its change with time. It is found that the viscosity values vary very much with the rate of shear. Measurements are made of the rate of flow through a capillary tube at a limiting high velocity. The graph giving the change with time shows a similar series of breaks to those observed with the polarisation measurements. Determinations are finally made of the time variations in the modulus of elasticity. Changes in the sol form cannot be so well traced by this method, but in the later stages or gel form variations in the elasticity can be followed when measurements by the two former methods can no longer be applied. By plotting dx/dt against x where x is the elasticity, the resulting graph consists of four straight lines of different slopes, the first one corresponding to the third stage identified by the viscosity and polarisation measurements. In this way, it is considered that six distinct monomolecular reactions are made evident in the progress of gelatinisation.

A number of further measurements are made of the addition of different salts, bases, and acids on the progress of gelatinisation, and a comparison is made of the general data obtained with the behaviour of a number of other colloids. J. N. P.

3077. *Variations of the Insulating Power of Gels of Acroleïn according to the Degree of Condensation. Comparison with Variations of Density.* **C. Moureu, C. Dufraisse, L. Tampier** and **P. Gailliot.** (J. de Physique et le Radium, 5. pp. 161–167, June, 1924.)—In the course of some recent chemical researches upon acroleïn two of the present authors have observed that a series of reagents, acting as catalysers, had the property of transforming that substance little by little into " a transparent mass, hard and brittle, which retains for a long time the characteristic odour of acroleïn, and that without losing its limpidity." The study of this transformation, followed systematically, led to the discovery that it is possible by this means to obtain substances endowed with differing interesting properties, and, in particular, with a very high insulating power. In the present paper it is shown how this power of insulating varies with the progress of the transformation. There are other changes in physical properties, but the only other dealt with here is that of density. The subject is considered under the following heads: The gelification of acroleïn, its density and insulating power; the principle of the method of measurement; description of the apparatus; a description of the measuring operations. The results are shown in graphical form. A. E. G.

3078. *Formation of Colloid Solutions by Electrical Pulverisation in the High-Frequency Alternating-Current Arc.* **E. O. Kraemer** and **T. Svedberg.** (Am. Chem. Soc., J. 46. pp. 1980–1991, Sept., 1924.)—Four types of electrical circuit were either actually used or considered. In the Tesla coil method a 1-kw. Thorardson " wireless " transformer, with a maximum secondary voltage of 25,000, was used. This charged a condenser, which discharged across an air-quenched silver spark gap, through a coil in which oscillations of frequency of about 1×10^6 were produced. This formed the primary of the oscillation transformer, and the secondary was in series with a hot-wire ammeter and a micrometer spark gap in the liquid which formed the dispersion medium of the colloid solution. In the second method the micrometer spark gap in the liquid replaced the air-quenched silver spark gap, the result being that, in addition to the high-frequency discharge, a low-frequency discharge passed through the liquid. A modified Poulsen, or "undamped wave," circuit was also used, in which again the discharge of the condenser took place across the same gap as that in which the pulverisation of the electrode took place, and in which the current was a slightly damped, alternating, but non-symmetrical current of complex form; it contained direct current from the primary d.c. source. The rates of pulverisation, sediment formation, and the decomposition of the liquid used were studied, and the Tesla coil has been proved to be superior to the other methods for producing colloid solutions with minimum decomposition of the medium, and so with maximum purity. This is owing to the absence of direct and low-frequency current components in the colloid forming arc. H. N. A.

3079. *An Apparatus for the Accurate Determination of Solubilities.* **E. Cohen, W. A. T. de Meester** and **A. L. T. Moesveld.** (Zeits. phys. Chem. 112. pp. 150–155, Sept. 6, 1924.)—The results achieved by the process for the determination of solubilities at high pressures [Abstract 1478 (1923)] were so satisfactory that a similar apparatus was constructed for their determination at ordinary pressure and at high temperatures. Measurements of the solubility of thallium sulphate were made at temperatures of 30°, 50° and 60° C., and gave results closely agreeing with those of Berkeley [see Abstract 2361 (1904)]. The solubility of silver nitrate at 30° C., expressed in grammes of salt per 100 g. of saturated solution, was found to give a mean value of 73·82. The value of 73 found by Schreinemakers and de Baat [Arch. Néerl. 15. 415 (1910)] seems to point to the fact that saturation was not attained in their experiments. E. F.

3080. *Heat of Formation of Water Solutions of Hydrochloric Acid and Ammonia at Different Temperatures.* **M. Wrewsky** and **N. Sawaritzky.** (Zeits. phys. Chem. 112. pp. 90–96, Sept. 6, 1924.)—The test of solution of hydrochloric acid in water was determined at 3·6°, 21·5°, 42°, 62·3° C., and ammonia in water at 3°, 19·9°, 41°, 61° C., and at varying concentrations. The results, when drawn in curves, show that the heat of solution of HCl increases with the temperature, while that of ammonia decreases with the temperature. F. J. B.

3081. *A New Method for Taking Colloids out of Suspension.* (Chem. and Met. Eng. 31. p. 387, Sept. 8, 1924.)—Recent experiments carried out in France by A. Marx and J. Rozières have demonstrated the value of a new device for taking colloids out of suspension. This apparatus operates with a combination of centrifugal force and a highly charged electrical field. In operating on old oil with an ordinary centrifugal apparatus, composed of a bowl 0·60 meter in diameter resolved at 2700 r.p.m., the main part of colloids remained in suspension in the liquid. On the other hand, the electrical action alone was without effect. But when the liquid was submitted during five minutes to a simultaneous action of centrifugal force and a difference of potential of 40,000 volts, the liquid became absolutely clear.

In order to obtain this difference of potential, a direct current 110 volts ending in a 110/40,000-volt transformer was utilised. A rotative circuit breaker was placed on one terminal, cutting and re-establishing the current 14,000 times per minute. The positive pole was considered by the frame of the apparatus and the outside part of the steel bowl, and the negative pole by three copper wires isolated from the bowl and held by the winglets; their diameter was 40 cm. This device gives a motion to colloids in the two ways, the movement toward the sides being the stronger.

J. B. C. K.

3082. *The Kathodic Behaviour of Alloys. Part I. Iron-Nickel Alloys.* **S. Glasstone.** (Faraday Soc., Trans. 19. pp. 574–583; Disc., 583–585, March, 1924.)—The alloys are deposited electrolytically on lead kathodes from solutions containing varying proportions of ferrous and nickel sulphates in order to eliminate the variations in structure liable to occur in preparing alloys from fused mixtures of metals. The ratio of iron to nickel is determined in the solution, and also in the metal deposited under similar conditions to those of the experiments on a carbon kathode. Measurements of the kathodic potential made during deposition show that lower potentials are required for the deposition of mixtures of iron and nickel than for either of the pure metals, the deposits containing relatively more iron than the corresponding solutions. This may be due to the retarding action of iron on the discharge of nickel ions, or the influence of nickel on the negative catalytic effect of hydrogen in the discharge of iron ions, this being developed by Kremann and his co-workers. Hydrogen evolution at iron-nickel alloy electrodes takes place at lower potentials than for either of the pure metals, and in view of lack of definite knowledge of the cause of overvoltage, this effect cannot be satisfactorily explained. The result obtained in the presence of depolarisers show that the reduction efficiency of a given electrode does not depend entirely upon hydrogen overvoltage, the electrode itself having generally a positive or negative catalytic influence. In the *Discussion,* the method of finding the composition of the alloy is criticised, and it is pointed out that the observed lowering of overvoltage with the alloys may be due to increasing roughness of the metal surface. Attention is drawn to the work of Foerster, which appears to explain many of the author's observations. The bearing of the views of Tammann (Zeits. Anorg. Chem. 107. 1919) upon the problem is also discussed.

B. W. C.

3083. *Reported Transmutation of Mercury into Gold.* (Nature, 114. pp. 197–198, Aug. 9, 1924.)—Reference is made to the possibility of the disruption of the Hg nucleus with the production of Au as forecasted, on a theoretical basis, in a previous article [see Abstract 1807 (1924)]. A short account is given of the experimental details and subsequent analytical investigation associated with the recently announced discovery of A. Miethe that, in a specially improved type of mercury-vapour lamp developed by A. Jaenicke in connection with experiments on the colouration of transparent minerals and glasses induced by ultra-violet rays, the Hg employed becomes, under extra heavy current conditions, contaminated with Au. Whilst it is admitted that the amount of Au detected is very small, the point is made that the delicate analytical tests giving evidence of the presence of Au after electrical treatment fail to show with certainty the pre-existence of Au. A. B. C. L.

3084. *Constitution of Technical Iron.* **F. Wever.** (Zeits. Elektrochem. 30. pp. 376–382, Aug., 1924. Paper read before the Deut. Bunsen Gesell., Göttingen, 1924.)—The work on the constitution of iron as determined by X-ray analysis is reviewed. The parameter of the space lattice of a number of steels of different composition was determined. The composition of the steels considered varied from one containing 19·08 % manganese and 0·30 % carbon, and one containing 2·06 % manganese and 1·90 % carbon. The parameter of the space lattice was determined by the Debye-Scherrer camera, the nickel spectrum being used as a comparison spectrum. The measurements were made with a Zeiss comparator. The apparatus and method had a high degree of accuracy, and was free from systematic errors. The results show that in a managanese austenite steel the parameter increases with the increase in atomic percentage of carbon. The specific volume of manganese austenite steel was measured by the method of displacement, and it can be seen that the space lattice parameter and the specific volume change with the composition and the relationship is linear. The results can be calculated from the equation $\alpha = \alpha_0 + x_1\text{Mn} + y_1\text{C}$, where α_0 is the parameter of pure iron, Mn and C the atomic percentages of manganese and carbon. Calculating the constants by the method of least squares, the equation becomes: $\alpha = 3{\cdot}578 + 0{\cdot}00050\ \text{Mn} + 0{\cdot}00645\ \text{C}$, with a mean error of $\pm\ 0{\cdot}0009 \times 10^{-8}$ cm. The structure of σ iron in annealed carbon steel was also determined and the space lattice compared with that of γ iron. The structure of carbon steels in the hardened condition was also determined, and the effect of carbon on the structure of the space lattice was discussed. F. J. B.

3085. *The Hydrogen Overvoltage of Metals and their Characteristic Properties. Part I. Overvoltage and Valency. Part II. Overvoltage and Melting-Points.* **E. J. Weeks.** (Chem. News, 128. pp. 359–360, June 6, and 129. p. 17, July 11, 1924.)—It is assumed by Newbery [see Abstract 180 (1917)] that overvoltage is a function of valency—*i.e.* a periodic function—and from this the formation of unstable intermediate hydrites to account for overvoltage effects is deduced. An examination of the tabulated average values of overvoltage as determined by different workers shows no absolute relation between overvoltage and valency, although there is a tendency for overvoltage to decrease with increasing valency. The theory of Newbery must therefore be considered untenable. It is shown that in general the higher the melting-point, of a metal, the lower is its hydrogen overvoltage. Mercury, melting-point − 35° C., has the highest overvoltage, 0·69 volt, while rhodium, melting-point over 3000° C., has the lowest, 0·00 volt. These results apply only to overvoltages in acid solution. B. W. C.

3086. *Magnesium.* (Chem. and Met. Eng. 31. pp. 383–386, Sept. 8, 1924.)—New metallurgical developments have made possible the manufacture of magnesium on a large scale, and at a reasonable price, and in a high state of purity. It is stated that magnesium is in a position similar to that once held by aluminium. The present article gives a survey of the principal chemical and mechanical properties of magnesium and its alloys. It is pointed out that if the troublesome impurities, principally sodium and chlorides, are avoided, the corrosion tendency is lessened considerably. As regards the question of the inflammability of the metal, this is no doubt a serious factor in the case of the powder or thin shavings exposed to an open light, but in the bulk is almost negligible, since magnesium has a melting-point of 1200° F. The powdered metal is now used as a dehydrating agent. As a deoxidiser in the manufacture of many metals and alloys, magnesium has found a valuable application. A new American process for producing magnesium is described; it depends upon the electrolysing of magnesium oxide. The oxide is added to a bath of fused fluorides, principally magnesium fluoride, in a special type electric furnace. Magnesium oxide is continuously added to the bath, while magnesium metal is removed at one electrode; carbon monoxide is evolved at the other. Even this quality of magnesium cannot be set down as a "corrosion-resisting metal," but it is much better than most other commercial varieties. A promising new treatment is under test for making magnesium and its alloys highly resistant to salt water and similar natural corrosives. One of the principal advantages of magnesium is its low density, namely, 1·74; with 10 % of aluminium it is 1·80. Suitable alloys of magnesium, with copper, cadmium, calcium, zinc and aluminium, have great strength combined with lightness. These alloys are being used for automobile engine parts; the blades of supercharger blower-impellers are now made of magnesium alloy. Magnesium presents difficulties as regards casting, forging and welding, but it is easily worked and machined. A. W. J.

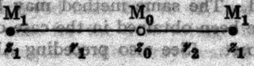
3087. *On Partial Equilibrium.* **E. Baur.** (Zeits. phys. Chem. 112. pp. 199–205, Sept. 20, 1924.)—If a chemical system be in a state of non-equilibrium its like behaviour on either side of the equilibrium condition may be expected, and true or false equilibrium in consequence can be detected. The present paper discusses examples of partial or one-sided equilibrium, such as Marc found, for example, with certain salt crystals which, when coloured with certain dyestuffs, no longer developed when placed in supersaturated aqueous solutions, although dissolving in dilute solutions to their normal saturation equilibrium. Four special cases exhibiting such equilibrium are now dealt with, *viz.* the decompositions of salicylic acid, of the anions of phloroglucinol carbonic acid, of amino acids by hydrolysis, and of sodium oxalate. These represent respectively a gas, a pure solvent, a solvent with carbon content, and a heterogeneous reaction. Data by Orthner, Piazza, Wunderly, and Ott are quoted. The work of Wunderly on the hydrolysis of amino acids is discussed in detail as affording the best examples of one-sided equilibria. The aliphatic amino acids, such as glycine, alanine, leucine and asparagine, were regarded as unsaponifiable until Wunderly employed animal charcoal as a catalyst for this purpose, when decomposition limits were found which were dependent on concentration, as though corresponding to the mass-action law. These limits are found to represent equilibria and the carbon catalyst to exert a one-sided effect, since a reversal of the reaction does not take place. H. H. Ho.

3088. *Decomposition of Hydrogen Iodide.* **H. A. Taylor.** (J. Phys. Chem. 28. pp. 984–991, Sept., 1924.)—Experimental arrangements are described by which pure hydrogen iodide in definite amounts is passed through heated tubes at constant prescribed temperatures (ranging from

400° to 500° C.) and at constant rate, the HI and I present in the resulting gas being determined by the usual titration methods. The decomposition tubes employed are made to offer varied amounts of glass surface by the introduction of bends, glass bulbs, and by the insertion of glass powder. The results demonstrate the effect of a change in the extent of surface, maintaining the volume of reactant constant, and show the decomposition to be a composite of a surface reaction and a reaction in the gas phase. The temperature coefficient of the surface reaction is 1·1 for 10°, whilst that for the reaction in the gas phase is approximately 2·0 in the temperature range employed. The general bearing of the results on the recent theoretical considerations of gas kinetics is indicated. Of the many so-called homogeneous gas reactions so far studied, only one—*viz.* the formation of PCl_5 from PCl_3 and Cl—would appear to be truly so.

A. B. C. L.

3089. *The Effect of the Deformability of Ions on Optical and Chemical Constants. Part II.* **W. Heisenberg.** (Zeits. f. Physik, 26. 3. pp. 196–204, 1924.)—This paper is a continuation of Part I [see Abstract 2178 (1924)], in which the author discussed binary molecules. He now considers triatomic molecules, in which all three atoms may be supposed to lie on a straight line; whether this holds for molecules like H_2O, CO_2 is not considered. It is shown that the existence of an electrical moment ought not to be looked upon as an argument for a triangular model of these molecules, but that this electrical moment is in general brought about by a characteristic dissymmetry caused by the deformability of the ions. The author considers the case of an ion



M_0, with charge z_0 at distances r_1 r_2, from two ions, M_1 with charge z_1. The forces considered are: (1) The electrostatic force; (2) a repulsive force between M_0 and M_1 of the form $\frac{be^2}{r^n}$; (3) the effect of deformability. For the sake of simplicity only M_0 is considered to be deformable and of amount a (see Part I). If p = electrical moment of M_0, the total energy of the molecule (see Part I, equation 11) is

$$\phi = z_0 z_1 e^2\left(\frac{1}{r_1}+\frac{1}{r_2}\right)+\frac{z_1^2 e^2}{r_1+r_2}+be^2\left(\frac{1}{r_1^n}+\frac{1}{r_2^n}\right)+pez_1\left(\frac{1}{r_1^2}-\frac{1}{r_2^2}\right)+\frac{p^2}{2a}$$

The conditions for equilibrium are: $\frac{\partial\phi}{\partial p}=0$, $\frac{\partial\phi}{\partial r_1}=0$, $\frac{\partial\phi}{\partial r_2}=0$, with the abbreviations $r_1 = u^{n-1}\sqrt{nb}$, $r_2 = v^{n-1}\sqrt{nb}$, $\frac{a}{(nb)^{\frac{3}{n-1}}}=\beta$, these conditions are worked out, and curves representing the last two conditions are plotted for the cases $\beta = 0\cdot5$ and $\beta = 1\cdot5$. Three possible equilibrium positions are given in the latter case. The stability of these equilibrium positions is now determined. The two outer are found to be stable and the middle one unstable. The preceding method is now applied to the ions $\overset{+}{\mathrm{Na}}$, $\overset{-}{\mathrm{Cl}}$, $\overset{+}{\mathrm{Na}}$ and $\overset{-}{\mathrm{Cl}}$, $\overset{+}{\mathrm{Na}}$, $\overset{-}{\mathrm{Cl}}$. A short discussion of Nernst's objection to Kossel's theory of rigid molecules follows; finally, the chemical constants of $\overset{+}{Na}\overset{-}{Cl}$, $\overset{+}{Na}\overset{-}{Cl}\overset{+}{Na}$, $\overset{-}{Cl}\overset{+}{Na}\overset{-}{Cl}$ are calculated by Stern and Fowler's method, and the conclusion is reached that the polar character of molecules may be approximately expressed by the deformability of the ions. T. B.

3090. *The Influence of the Deformability of Ions on Optical and Chemical Constants. Part III. The Specific Oscillations of* CO_3^{--}. **H. Kornfeld.** (Zeits. f. Physik, 26. 3. pp. 205–222, 1924.)—The carbonate ion CO_3^{--} is considered to be formed on a triangular model, an oxygen atom being at each corner of an equilateral triangle with the carbon atom at the centre of the triangle. From the measurements of Schäfer and Schubert [see Abstract 1241 (1916)], for such a model there are three ultra-red oscillations with wave-lengths $6\cdot5\mu$, $11\cdot5\mu$, $14\cdot5\mu$; of these the middle one is polarised in the plane of the model and the other two at right angles to the plane. C. J. Brester has obtained results [see Kristallsymmetrie in Reststrablen Disser., Utrecht, 1923, p. 115, and see Abstract 2435 (1924)] which are in agreement with this. The author attempts to explain these experimental results by a mathematical investigation of the energy of the complex ion. For this purpose he assumes that, in addition to the polar constituent C^{++++}, O^{--}, there is also the action of the dipolar moment caused by the deformation of the ion. With this hypothesis he obtains results which are in agreement with those of Born and W. Heisenberg [see Abstract 2178 (1924)], although the hypothesis can only be regarded as a rough approximation. The solution of the energy equation is complicated, and a mathematical appendix of ten pages gives proofs of the theorems required. The same method may be expected to explain the results which have been obtained in the case of distorted CO_3 groups by Schäfer and Schubert. [See also preceding Abstract.] T. B.

3091. *Chemical Constants of Chlorine, Bromine, and Iodine in the Mono- and Di-atomic States.* **K. Wohl.** (Zeits. phys. Chem. 110. pp. 166–187, 1924.)—The chemical constants of monatomic chlorine, bromine, and iodine are probably $0\cdot93$, $0\cdot80$, and $0\cdot52$ respectively greater than the theoretical values, and certainly at least $0\cdot63$, $0\cdot25$ and $0\cdot29$ greater. The deviation thus appears to increase in the sense of the heats of dissociation. It is possible, indeed, that the divergence in each of the three cases is about $0\cdot7 = \log 5$, and in any event it exceeds the value $0\cdot3 = \log 2$, which, according to Schottky's theory, is the most probable and the smallest possible deviation. Since for mercury the value is less than $0\cdot3$, this theory requires modification to suit each new case. Further, it is difficult to maintain Schottky's assumption that this divergence of the chemical constant from the theoretical value originates in the relations of the fundamental substance, and is therefore connected with at least a "practical" disagreement with Nernst's heat theorem. T. H. P.

3092. *Chemical Constants of Monatomic Gases.* **F. Simon.** (Zeits. phys. Chem. 110. pp. 572–586, 1924.)—The marked divergence shown by recent determinations to exist between the chemical constants of monatomic gases and the theoretical values is discussed, and it is pointed out that the magnitude of such divergence increases with the difference in energy between the monatomic gas and the condensate. Various possible explanations of this phenomenon are advanced [see preceding abstract]. T. H. P.

3093. *Influence of Some Non-Inflammable Vapours of Organic Liquids on the Limits of Inflammability of Methane-Air Mixtures.* **W. P. Jorissen** and **J. Velisek.** (Rec. des Trav. Chim. des Pays Bas, 43. pp. 80–86, Jan. 15, 1924.)—By means of a burette fitted with a platinum point spark gap determinations are made with methane-air mixtures of the limiting proportions which, in the presence of various organic inhibiting agents, enable the propagation of ignition. The temperature of the gases varied in the different experiments from 10° to 20° C. With methane-air alone the limits of inflammability are 5·4 and 14·1 %; with 0·7 and 0·8 % perchlorethylene, 7·35 and 10·15 % methane; with 0·7 and 0·8 % tetrachlorethane, 7·15 and 9·15 % methane; with 1 % pentachlorethane, 5·95 and 10·3 % methane; with 20 % dichlorethylene no explosion occurred; with 5·5 % trichlorethylene no explosion occurred; with 8·5 % carbon tetrachloride the limits are 9·0 and 9·9 %; and with 12·2 % carbon tetrachloride no explosion occurred. Whether the action of these vapours and others in reducing the explosibility of methane can be accounted for by their higher molecular heat or whether it is partly due to some catalytic influence remains to be investigated. J. N. P.

3094. *The Sensitiveness of Selenium Cells to X-Rays of Different Wave-Lengths.* **H. Küstner.** (Zeits. f. Physik, 27. 2. pp. 124–137, 1924.)—A selenium cell was compared with two carbon ionisation chambers, one of which was 25·5 cm. high and 6·4 cm. in diameter, and the other, a thimble chamber, 21 mm. high and 14 mm. in diameter. It was not possible to use strictly monochromatic X-rays, as the selenium cell was not sufficiently sensitive, but the hardness was controlled and measured by varying the kilovolts employed from 205 to 42, and the thickness of the copper filter from 1·90 mm. for the first voltage to 0·075 mm. for the last; the average wave-length of the X-rays varied from 0·119 Å. in the first case to 0·473 Å. in the last. The ratio of the ionisations produced in the two chambers varied only a little throughout the range employed; but that of the effect on the selenium cell, measured in Fürstenau units, to the ionisation in the large chamber showed a decided maximum at about 0·22 Å. At 0·12 Å. and 0·4 Å. the selenium cell, compared with the ionisation chamber, is only half as sensitive as at 0·22 Å. This maximum has certainly nothing to do with an absorption "spring"; the shortest wave-length absorption band head of selenium is at 0·979 Å. The fact that there is so little difference in the ratio of the two ionisation chambers, which differ so greatly in dimensions, seems to exclude the explanation that the effect is due to a minimum sensitiveness of the ionisation chambers at 0·22 Å. It is shown that it is possible to explain the effect on certain assumptions as to the absorption and scattering of X-rays in selenium and in air. H. N. A.

3095. *The Electro-chemical Behaviour of Chromium.* **N. Bouman.** (Rec. des Trav. Chim. des Pays Bas, 43. pp. 1–29, Jan. 15, 1924.)—Measurements are made of the e.m.f. of chromium of varying forms in different electrolytes. With crystals of metal prepared by the Goldschmidt process different crystals showed different potentials, while two electrodes from the same crystal showed practically the same potential. The variation is attributed to the presence of traces of impurities. Electrolytically deposited metal gives a constant potential when in the active form, but when in the passive form the potentials vary with the metal on which the chromium is deposited, indicating that the deposits are not continuous. On removing the basis metal, constant potentials are given which, however, are 500 millivolts more negative than chromium prepared by the Goldschmidt process. In distinction from iron, chromium is normally in a passive condition, and only assumes the active state when treated with some activating agent. Passivity is readily produced by contact with nitric acid and some other oxygen acids and by anodic polarisation. Chromium appears to remain active only when the acidity is not under a certain limit, *i.e.* about 10^{-3} N. Various methods of activating the metal are described, such as touching with zinc, dipping in certain heated salt solutions or hydrochloric acid, or by kathodic polarisation. The potential of the metal thus obtained is practically constant and independent of the method of activation. In an electrolyte of a mixture of chromic and chromous sulphate the potential is practically independent of the ratio and concentration of the salts. With increasing $H^{\cdot}$ ion concentration of an electrolyte the potential becomes more positive in sulphuric acid solution and more negative in hydrochloric acid solution.

The main theories which have been put forward to account for the passivity of chromium are reviewed. It is considered that the phenomena are best explained by the theory of allotropy, according to which a heterogeneous equilibrium exists between different states of the metal. Passivation and the different potentials obtained with different samples of metal are attributed to retardations of the internal transformations in the metal and to retardations in the adjustment of equilibrium between the divalent, trivalent, and hexavalent chromium ions in the solution. In agreement with this view, the passive state becomes more stable by lowering the temperature. If active chromium is polarised with a small anodic current, it passes into solution as divalent ions. As the c.d. increases, the solution stops at a c.d., which is dependent on the nature of the electrolyte. The so-called critical c.d. increases with the $H^{\cdot}$ ion concentration and the Cl' ion concentration, which are thus catalysts for the establishment of the internal equilibrium. With a charge of about 1250 millivolts, the metal passes directly into solution as chromatic ions. J. N. P.

3096. *The Electrometric Titration of Chromic Acid, using (a) the Hydrogen Electrode, and (b) the Oxygen Electrode.* **H. T. S. Britton.** (Chem. Soc., J. 125. pp. 1572–1582, Aug., 1924.)—Solutions of chromic acid are titrated electrometrically with the hydrogen electrode and the oxygen electrode. The investigations show that chromic acid exists in solution as a normal dibasic acid, H_2CrO_4, dissociating almost completely as $H_2CrO_4 \rightleftarrows H^{\cdot} + HCrO_4'$ in dilute solution, while the secondary dissociation $HCrO_4 \rightleftarrows H^{\cdot} + CrO_4''$ is very small, the dissociation constant being $4{\cdot}4 \times 10^{-7}$. The preparation of hydrogen electrodes for use with chromates, nitrates and reducible compounds is discussed. It is shown that the oxygen electrode may be used as an indicator for both *p*H values and end-points if suitably calibrated. The dibasicity of chromic acid explains satisfactorily many of the reactions of the acid and the chromates. B. W. C.

3097. *Catalytic Action of Nitrous Acid.* **W. D. Bancroft.** (J. Phys. Chem. 28. pp. 973–983, Sept., 1924.)—Previous papers bearing on the reaction between nitric acid and metals such as copper, silver, etc., are quoted at considerable length and discussed. In particular the experiments and conclusions of Veley [Roy. Soc., Phil. Trans. 182 A. 279, 1891] are freely cited and criticised. It is claimed that, under the conditions prevailing in Veley's experiments, nitrous acid is not so strong an oxidising agent as nitric acid and does not act as the depolariser, and that nitrous acid acts catalytically in activating nitric acid. It is thought probable that the activation of nitric acid depends on the dynamic equilibrium represented by the equation $HNO_3 + HNO_2 \rightleftarrows 2NO_2 + H_2O$. This interpretation brings the action of nitrous acid into line with the action of light and of solid catalytic agents. The theorem is proposed that if a state of dynamic equilibrium involves activation in certain directions, this must be a general phenomenon, and must be shown to occur in all such cases. A. B. C. L.

3098. *The Passivity of Metals, with Particular Reference to Iron.* **W. J. Müller.** (Zeits. Elektrochem. 30. pp. 401–416, Sept., 1924.)—The development of passivity in a stable active metal during electrolysis is considered to be accompanied in the first place by the separation of an insulating layer of salt on the surface of the anode, the concentration of which has exceeded the solubility in the neighbouring solution. The increase of effective current density and potential due to the partially insulating layer leads to the passive condition on account of the metal-metal ion-electron equilibrium in the surface of the metal being displaced in the direction of metal ions of higher valency, which no longer pass into solution. The influence of different electrolytes is considered briefly, and, as an instance of a stable passive metal, the behaviour of platinum on activation with alternating current. Chromium, the properties of which are described, provides an instance where the passive condition of the metal appears to be stable while the active condition is, to a high degree, metastable. The anodic passivation of iron in sodium sulphate solution is demonstrated experimentally. The formation of the layer of ferrous sulphate is seen by the darkening of the electrode, while passivity is accompanied by a brightening appearance. Oxygen evolution and solution of the insulating layer, which is calculated to be of a thickness of 0·01 mm., are observed. Time phenomena are investigated by means of horizontally placed electrodes. The time required for the passivation of iron may vary from 2 to 1000 seconds, according to the current density. The relation between mean current density and time for passivity is found to be given approximately by the formula: $(i - i_0)t/\log t = K$, where i is the mean prevailing c.d. during the passivation, and represents the amount of ions passing into solution, i_0 is the c.d. of the ions which diffuse away from the layer of saturation concentration, and t is the time taken for complete passivation. $i - i_0$ thus represents the amount of ions precipitated as solid salt in unit time. It is found in accordance with this relation that the passivating effect of an anion is inversely proportional to the solubility of the compound formed in the layer. The relation further shows that the thickness of the layer is inversely proportional to the logarithm of the time required for its formation. This is in agreement with the relation that the size of particles of precipitates is proportional to the degree of supersaturation or time required for formation. The formation of the covering layer is shown by the increase of the resistance to which the so-called chemical polarisation is to be ascribed. This consideration, and the fact that passive iron at 0·6 volt can be obtained free from all covering layer, shows that neither oxygen or oxide layer can be the cause of passivity. Polarisation is thus attributed to resistance effects, and is not related to reaction velocities of processes leading to solution of the electrode metal. In presence of an oxidising medium and the absence of an externally applied p.d., local electrolytic action occurs, producing anodically passivated and kathodically polarised areas. The latter may be continuously or intermittently depolarised by the solution, according to its nature, leading either to complete passivity or pulsating effects.

J. N. P.

3099. *On the Theory of Binary Electrolytes.* **W. Sementschenko.** (Zeits. phys. Chem. 112. pp. 128–134, Sept. 6, 1924.)—This investigation is made on the assumption that the number of ions in comparison with the number of solvent molecules is so insignificant that the dielectric constant of the solvent can be regarded in the ordinary macroscopic sense [see Abstract 2541 (1923)]; also that every ion is surrounded by a zone within which another ion can no longer avoid the attractive forces, thereby reforming an undissociated molecule. Based on Coulomb's law, an equation has been derived connecting degree of dissociation α of the electrolyte, dilution V, and dielectric constant of the solvent ϵ, *viz.* $n_1/N_1 = ((mC_0^2) . e_1e_2/2)^3 V\epsilon^3/n_1\alpha$, where N_1 and n_1 are the numbers of undissociated molecules and ions of both kinds respectively, C_0 a particular velocity, and e_1 and e_1 the ionic charges. The Ostwald dilution law and also that of Walden follow as special cases from this equation, as well as Walden's empirical relations, $K_0 = \text{const.}\ \epsilon^3$, and $K_0 = \text{const.}\ \epsilon^2/\sqrt[3]{V}$, where K_0 is the constant of the Ostwald dilution law. This equation also enables a more extended quantitative development of the hypothesis of dissociating complexes. It explains the existence of maximum and minimum conductivity, and can be applied to the consideration of concentrated solutions by an enlargement of ϵ.

H. H. Ho.

3100. *The Electrolysis of Soda-Lime Glass. I. Evolution of Gas and its Relation to Sorption and Conductivity.* **J. W. Rebbeck** and **J. B. Ferguson.** (Am. Chem. Soc., J. 46. pp. 1991–2002, Sept., 1924.)—Sorption apparently includes adsorption and absorption, and the authors show that the gas evolved under certain conditions of electrolysis is related to the "sorbed" water of the glass. A glass bulb was filled with mercury by distillation at low pressure; it was then placed in a test-tube containing dilute sodium hydroxide in a heating bath. When the Hg was heated, the kathode gas was formed between the Hg and the glass at rates depending on the voltage and the temperature. None was formed in several days at 94° C. and with 1·0 volt, though 1·3 volts gave a noticeable layer in about 20 hours; 110 volts gives a visible layer at room temperature in 20 hours. No gas was produced when the mercury was the anode, by an alternating current or in tubes which were annealed or baked *in vacuo* at 350° for many hours. Samples of the gas formed were analysed, and consisted of H and O, with the former predominating; this, and the facts that heating the glass prevents the formation of gas, and that if the glass is then exposed to water-vapour or liquid water it regains this property, point to the fact that the gas is produced from water. The phenomenon is not a simple electrolysis of a water film, since the gas does not contain H and O in the requisite proportions, and it seems probable that the sodium ions, which carry the current at high temperatures, play a major rôle in the production of the gas.

H. N. A.